THE

AMERICAN ORTHOPTIC JOURNAL

1955

VOLUME 5

Official Organ of

AMERICAN ASSOCIATION

of

ORTHOPTIC TECHNICIANS

Sponsored by the

AMERICAN ORTHOPTIC COUNCIL

Published as a Supplement to the TRANSACTIONS of the American Academy of Ophthalmology and Otolaryngology, 100 First Avenue Building, Rochester, Minnesota, and printed by the Douglas Printing Company, 109 North 18th Street, Omaha 2, Nebraska.

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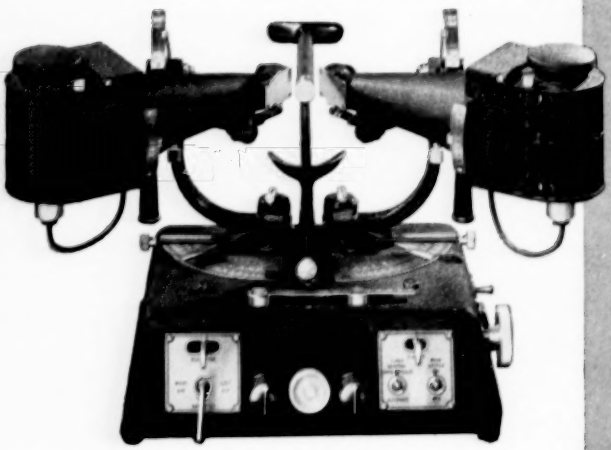

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Symposium: Surgery and Orthoptics

MUSCLE SURGERY AND ORTHOPTICS

EDMOND L. COOPER, M.D.
DETROIT, MICHIGAN

BEFORE discussing the relative value of surgery and orthoptics in curing comitant strabismus, we first have to define a satisfactory cure. One cannot say that strabismus is functionally cured unless (1) no tropia is shown by the cover test either for distance or near; (2) the patient is able to fuse Worth's four dots both for distance and near; (3) the patient is able to fuse with a red glass before one eye both for distance and near; (4) visual acuity is equal, or nearly so, in each eye; and (5) there is no incomitance. To be more thorough, one might add the requirements of bar reading, physiologic diplopia, fusion with amplitude, a near point of convergence of at least 100 mm., and fusion and clear vision on the Remy separator.

Using these minimum standards, we have attempted to evaluate 333 cases of comitant esotropia and 77 cases of comitant exotropia, all of which were first seen between June 1945 and January 1954, and all of which eventually were operated upon. We eliminated 15 other cases from this study because the patients did not return following surgery, or for other reasons. Since only those cases involving surgery have been included, this study does not consider accommodative esotropia; neither does it include some cases of intermittent exotropia which were satisfactorily cured with refraction and orthoptics alone.

Not all of the cases were clear-cut. Age is a factor. A test is not always conclusive, for example, in the case of a child two or three years old. In some cases we felt that some degree of fusion was present postoperatively in children in this age range, because the cover test showed no more than a phoria and convergence was good, even though we were unable to utilize Worth's four dots or other tests to substantiate the diagnosis. For the purpose of this report we considered such cases functionally cured.

The current trend among ophthalmologists in all parts of the world, particularly in America, is toward early surgery. We tend to operate much earlier than we used to; actually we will perform surgery for nonaccommodative comitant strabismus as soon as a satisfactory diagnosis has been made, provided vision is equal in both eyes and the patient alternates freely. We have no minimum age limit below which we will not operate, although we agree with Lyle that because the binocular reflexes are undeveloped in the first year of life, there is little to be gained by surgery before the child is fifteen months old.

Table I shows the results of surgery in the 333 cases of comitant convergent strabismus. Some cases were treated orthoptically both before and after surgery, and many were treated by occlusion for amblyopia and anomalous retinal correspondence. Twenty-six per cent of all cases treated surgically were functionally cured. Cases complicated by a high vertical anomaly, anisometropia, intractable amblyopia, or other entities which render a functional improvement unlikely, if not impossible, are included in the total number, so a functional cure in one fourth of the cases does

Read at the Annual Joint Meeting of the American Orthoptic Council and the American Association of Orthoptic Technicians, Sept. 19, 1954, New York, N. Y.

TABLE I

RESULTS OF TREATMENT BY SURGERY ALONE AND BY SURGERY COMBINED WITH ORTHOPTICS IN NONACCOMMODATIVE COMITANT ESOTROPIA

GROUP	AGE IN YEARS AT OPERATION	NO. OF CASES	FUNCTIONAL CURE			COSMETIC IMPROVEMENT ONLY		
			SURGERY ALONE	SURGERY & ORTHOPTICS	PERCENTAGE OF CASES	SURGERY ALONE	SURGERY & ORTHOPTICS	PERCENTAGE OF CASES
I	0-3	60	16	2	30	29	13	70
II	4-5	99	13	22	35.4	34	30	64.6
III	6-7	61	2	14	26.3	18	27	73.7
IV	8-12	58	2	8	17.3	20	28	82.7
V	Over 12	55	5	3	14.6	40	7	85.4
All cases	0 to over 12	333	38	49	26.1	141	105	73.9

not seem unsatisfactory. It can be seen that the percentage of successful results is higher in cases operated upon before the age of 6 years, and that the number of successful results diminishes in each succeeding age group.

Functional improvements in children from birth to the third year are obtained without benefit of orthoptic training, and the only form of training we ever undertake with these patients is occlusion in order to produce alternation. In Group II, more patients are amenable to orthoptic training and there is a slight increase in the percentage of functional cures. We are inclined to believe, however, that the important factor in these two groups is the relatively young age at the time of surgery; orthoptics seems to be important as a supplement.

Fusion is a phenomenon which requires time and practice for its development. Everyone is born with the potential ability to fuse, but if an obstacle is present, fusion may not develop. When the obstacle is an insurmountable deviation, fusion may be made possible by surgery. But it must be done early. It must be done while there is still an opportunity for development to take place, and usually this is too early for orthoptics to be of much assistance. This is particularly true of cases with early onset. Cases with later onset will occasionally develop fusion even if operation is deferred till after the age of 12. Five such cases are in group V; three of them were adults.

We obtained a fusional result in only 20.4 percent of those cases in which the onset occurred before the child was 18 months of age, and in 30.9 percent of those cases the onset of which occurred after 18 months (table I-A).

We employ orthoptic training regularly when cooperation of the patient is adequate and visual acuity is equal, or nearly equal, in the two eyes. In group III the number of patients who attained a func-

TABLE I-A

AGE AT ONSET OF NONACCOMMODATIVE COMITANT ESOTROPIA AS RELATED TO RESULTS OF TREATMENT IN 333 CASES

AGE AT ONSET	NO. OF CASES	FUNCTIONAL CURE		COSMETIC IMPROVEMENT ONLY	
		NUMBER	PECENTAGE OF CASES	NUMBER	PERCENTAGE OF CASES
Less than 18 mos.	132	27	20.4	105	79.5
More than 18 mos.	171	53	30.9	118	69.1
Unknown	30	7	23.3	23	76.7
All cases	333	87	26.1	246	73.9

tional cure without benefit of orthoptics is markedly diminished, and in this group we must depend largely on orthoptic training to re-educate the fusional reflexes. There is still a higher percentage of successful results in this group than in the over-all series.

After the age of 7 years (groups IV and V) the number of successful results from surgery, either with or without orthoptics, is smaller.

Table II shows the results of surgery and orthoptics in comitant divergent strabismus. It can be seen that the percentage of successful results is approximately the same in all age groups. Here the need for early surgery is certainly not apparent. The reason is obvious. Most cases of divergent strabismus, particularly in children, are intermittent or periodic, or both, and these patients exhibit fairly good fusional capacity. Some of these patients never require surgery, because the elimination of suppression and increase in fusional amplitudes by orthoptic training enables them to keep their deviation latent.

Twenty-nine of these cases, however, showed exotropia which was constant (Table III) and roughly half attained a functional cure. Here the successful results were in the older age groups, and here again there is no reason to believe that early surgery is as important as it is in convergent strabismus.

During the past five years we have been performing surgery symmetrically whenever possible in order to reduce the incidence of postoperative incomitance. The required amount of recession or resection is divided between the two eyes, usually at the same operation. Our experience shows that nonsymmetrical surgery is frequently followed by incomitance, usually in the field of action of a recessed muscle. Figure 1 illustrates the prism cover measurements in a patient thus operated on and is shown only as an example. It should be obvious that a functional cure is unattainable in such a case, since the surgery has only replaced a comitant deviation with an incomitant one. We perform symmetrical surgery in all cases in which we feel that there is a chance for a functional cure unless the amount of correction required is so small that it cannot be divided between the two eyes. Nonsymmetrical surgery is still done in cases of intractable amblyopia, when the child is Mongoloid or otherwise mentally deficient, in cases with amblyopia due to an organic change in one eye, in adult cases which show no fusional capacity at all, and in cases in which a cosmetic improvement is all that can be expected. Recently, Costenbader has emphasized the importance of symmetrical surgery and the part played by postoperative incomitance in preventing a functional cure.

TABLE II
RESULTS OF TREATMENT BY SURGERY ALONE AND BY SURGERY COMBINED WITH ORTHOPTICS IN COMITANT EXOTROPIA

AGE IN YEARS AT OPERATION	NO. OF CASES	FUNCTIONAL CURE			COSMETIC IMPROVEMENT ONLY		
		SURGERY ALONE	SURGERY & ORTHOPTICS	PERCENTAGE OF CASES	SURGERY ALONE	SURGERY & ORTHOPTICS	PERCENTAGE OF CASES
0-3	11	8	0	72.8	3	0	27.2
4-5	12	0	9	75	2	1	25
6-7	17	3	9	70.6	5	0	29.4
8-12	17	1	13	82.4	2	1	17.6
Over 12	20	3	9	60	8	0	40
All cases	77	15	40	71.5	20	2	28.5

Table IV demonstrates the value of symmetrical surgery in helping to provide a functional cure in comitant convergent strabismus. Slightly more than one fourth of 333 cases in the series obtained a functional cure. Symmetrical surgery was performed in 120 cases, resulting in cure of nearly one half, whereas when nonsymmetrical surgery was employed, only 15 percent of the operations were successful. This may be explained partly on the basis of case selection, because we tend to use symmetrical surgery in cases in which we feel that there is a chance for success. But even when all cases in which there was no chance for cure are eliminated from the series, the percentage of successful results is higher when symmetrical surgery is done.

The same thing is true of comitant divergent strabismus (table V). Symmetrical surgery resulted in 83.9 percent cures in 31 cases. This percentage is 20 points higher than that obtained in 46 cases of nonsymmetrical surgery. In both groups, surgery combined with orthoptic training resulted in a higher percentage of cures than was obtained by means of surgery alone. We think it is very significant that only two of the cases which received orthoptic training were functional failures, whereas 20 cases out of 35 treated by surgery alone failed to obtain a cure.

We think there can be no doubt that surgery should be done symmetrically whenever possible, and particularly when there is a good chance that function can be established. The incomitance which follows nonsymmetrical surgery is a definite obstacle to proper alignment, normal correspondence, and fusion. Nonsymmetrical surgery should be limited to cases with no chance for cure, and to cases in which the correction indicated is too small to be divided between the two eyes. There is no objection, however, to performing surgery on the two eyes in two stages, because incomitance from unilateral sur-

TABLE III

RESULTS OF TREATMENT BY SURGERY ALONE AND BY SURGERY COMBINED WITH ORTHOPTICS IN CONSTANT COMITANT EXOTROPIA; A SUBGROUP FROM TABLE II

AGE IN YEARS AT OPERATION	NO. OF CASES	FUNCTIONAL CURE		COSMETIC IMPROVEMENT ONLY	
		SURGERY ALONE	SURGERY & ORTHOPTICS	SURGERY ALONE	SURGERY & ORTHOPTICS
0-3	3	0	0	3	0
4-5	1	0	0	1	0
6-7	5	0	1	4	0
8-12	4	1	3	0	0
Over 12	16	4	5	7	0
All cases	29	5	9	15	0

Preoperative
Esotropia at 20′ = 48
Esotropia at 13″ = 50

D. B., age 8
Operation
Recession RMR 3 mm.
Resection RLR 7 mm.

Postoperative
Esotropia at 20′ = 2
Exotropia at 13″ = 10

FIG. 1—Incomitance following nonsymmetrical surgery. Numbers refer to prism diopters.

gery may be overcome by performing a similar procedure on the other eye.

We know, as you do, that the results of muscle surgery cannot be accurately predicted. But we feel strongly that all muscle surgery should be graded. The idea, for instance, of indiscriminately doing all recessions to the equator is untenable. Technique in muscle surgery varies widely with different surgeons, and so it is impossible for one to advise another how much recession or resection to do in

TABLE IV

COMPARISON OF RESULTS OF SYMMETRICAL AND NONSYMMETRICAL SURGERY IN CASES OF NONACCOMMODATIVE COMITANT ESOTROPIA

TYPE OF SURGERY	NO. OF CASES	FUNCTIONAL CURE			COSMETIC IMPROVEMENT ONLY		
		SURGERY ONLY	SURGERY & ORTHOPTICS	PERCENTAGE OF CASES	SURGERY ONLY	SURGERY & ORTHOPTICS	PERCENTAGE OF CASES
Symmetrical	120	27	28	45.9	57	28	54.1
Nonsymmetrical	213	11	21	15	104	77	85
All cases	333	38	49	26.1	141	105	73.9

TABLE V

COMPARISON OF RESULTS OF SYMMETRICAL AND NONSYMMETRICAL SURGERY IN CASES OF COMITANT EXOTROPIA

TYPE OF SURGERY	NO. OF CASES	FUNCTIONAL CURE			COSMETIC IMPROVEMENT ONLY		
		SURGERY ONLY	SURGERY & ORTHOPTICS	PERCENTAGE OF CASES	SURGERY ONLY	SURGERY & ORTHOPTICS	PERCENTAGE OF CASES
Symmetrical	31	5	21	83.9	4	1	16.1
Nonsymmetrical	46	10	19	63.1	16	1	36.9
All cases	77	15	40	71.5	20	2	28.5

any given case. It should be possible, however, for a surgeon to judge for *himself* approximately what result *he* will get from a given procedure, provided, of course, that he has standardized his technique and has had enough experience with it. We do not pretend to know, prior to an operation, the number of millimeters of recession or resection which will result in the desired prism diopters of correction. We *do* think we know approximately, however, because we always measure during surgery and we always use the same technique. We rely almost entirely on recessions and resections. In determining how much correction to undertake, we place great emphasis on such factors as age of patient; age at onset; amount, intermittency, and variability of the squint measurements; status of retinal correspondence; presence of amblyopia, and the near point of convergence. This is simply a matter of experience.

Proper selection of cases is important in obtaining a satisfactory percentage of functional cures. In this regard the preoperative status of the patient must be considered. The chances for cure are greatly enhanced if the vision is equal (or nearly so) in each eye, and if there is free alternation on the part of the patient. On the other hand, anomalous retinal correspondence, anisometropia, and the presence of a high vertical component (over 5 prism diopters) in the primary position lessen the chances for cure.

Since free alternation implies equal vision in both eyes, they may be considered together. Table VI shows the results of surgical treatment when free alternation and equal vision are present preoperatively. One hundred sixty-seven of the 333 cases (almost exactly half) were in this category. Functional cure was obtained in 40.2 percent of them. On the other hand, when

TABLE VI

EFFECTS OF PREOPERATIVE STATUS ON RESULTS OF THERAPY IN CASES OF NONACCOMMODATIVE COMITANT ESOTROPIA

PREOPERATIVE STATUS	NO. OF CASES	FUNCTIONAL CURE			COSMETIC IMPROVEMENT ONLY		
		SURGERY ONLY	SURGERY & ORTHOPTICS	PERCENTAGE OF CASES	SURGERY ONLY	SURGERY & ORTHOPTICS	PERCENTAGE OF CASES
Free alternation and equal vision	167	31	36	40.2	61	39	59.8
Monocular fixation preference	166	7	13	12.1	80	66	87.9
All cases	333	38	49	26.1	141	105	73.9

alternation was *not* present preoperatively, the percentage of success was only 12.1. In cases in which there is some possibility that a functional cure may be the end result, we make every effort to equalize the vision by occlusion; when vision is equal, if voluntary alternation does not occur, we alternate occlusion until surgery has been done.

In the cases with free alternation and equal vision (table VI) the functional results are almost equally good whether or not orthoptic training is combined with surgery. This is certainly due to the fact that most patients in this group are also in the younger age group and frequently develop single binocular vision when the abnormality is corrected surgically. It is much more difficult to teach alternation to older patients, especially if the squint is of more than a few months duration. A functional cure is obtained twice as often when orthoptic training supplements the surgery as when it does not. We have found also that consecutive divergence does not often result from surgery on alternation, and this is an added incentive to encourage alternation preoperatively.

Table VII shows the result of treatment in 77 cases of comitant exotropia. Of those alternating freely preoperatively, 82.3 percent were functionally cured, while only 26.7 percent of nonalternators were functionally cured. It is even more significant that of 42 cases in which orthoptic treatment supplemented surgery, in only 2 did the treatment result in failure; whereas in 35 cases in which surgery alone was used, over half failed to achieve fusion. Does this not speak well for the value of orthoptic training? It does. But it should be remembered that there was no possibility for fusion in many of these 35 cases. When orthoptic training is used only in those cases in which it is felt it will be of some use, it is not surprising that the percentage of successful results will be high.

Anomalous retinal correspondence, anisometropia, and the presence of a high vertical component in the primary position lessen the chances for a functional cure.

There is very little which may be done about anisometropia except to correct it with glasses and to try to equalize vision when the difference in the refractive error between the two eyes is not too great. This can sometimes be done. We have one case in which a functional cure was obtained. More often, however, the anisometropia is too great to be overcome, and surgery, by necessity, is cosmetic. Four cases of more than moderate anisometropia are found in the series of 333 patients with comitant convergent strabismus. None of them obtained fusion postoperatively. One case of only moderate anisometropia is found in 77 patients with comitant exo-

TABLE VII

EFFECT OF PREOPERATIVE STATUS ON RESULTS OF THERAPY IN CASES OF COMITANT EXOTROPIA

PREOPERATIVE STATUS	NO. OF CASES	FUNCTIONAL CURE			COSMETIC IMPROVEMENT ONLY		
		SURGERY ONLY	SURGERY & ORTHOPTICS	PERCENTAGE OF CASES	SURGERY ONLY	SURGERY & ORTHOPTICS	PERCENTAGE OF CASES
Free alternation and equal vision	62	12	39	82.3	10	1	17.7
Monocular fixation preference	15	3	1	26.7	10	1	75.3
All cases	77	15	40	71.5	20	2	28.5

tropia, and this patient obtained a fusional cure.

The presence of a vertical component is also a serious obstacle on the road to functional success. In such cases, operation to correct the vertical error invariably is indicated, because no other form of treatment can hope to restore parallelism of the visual axes. No general rule can be laid down for surgery on vertically acting muscles, and the importance of a proper diagnosis cannot be overemphasized. When an obvious weakness of a vertically acting muscle exists, we believe that a shortening operation is the procedure of choice. Often, however, no gross weakness is apparent. We then perform a weakening procedure on the yoke muscle. This is usually the inferior oblique, and we prefer recessions of this muscle for hypertropias under 15 prism diopters, and myomectomies for hypertropias over 15 prism diopters. Overaction of the inferior oblique secondary to paresis of the contralateral superior rectus must be differentiated from the tendency of the adducted eye to turn upward, which is seen in esotropia of high degree. This upward deviation in adduction always disappears after surgery on the horizontal muscles is carried out, and operation for the upward deviation is unnecessary. In the 333 cases we are discussing, we found 66 which showed a definite vertical anomaly. Surgical correction of the vertical component was attempted whenever we felt that there was a chance for a functional cure. Table VIII shows that this was obtained in only 5 cases, or 7.8 percent. In each of these 5 cases, surgery resulted in complete correction of the vertical error. This percentage is so much lower than that of the over-all series that there can be no doubt that the existence of a vertical anomaly renders the chance of cure very small and that if a cure is to result, the vertical error must be corrected.

We found anomalous retinal correspondence in 85 of the 333 patients with nonaccommodative comitant esotropia, using the afterimage tests to confirm the diagnosis whenever testing on a major amblyoscope revealed an angle of anomaly. This incidence (25.5 percent) seems somewhat lower than that reported by others. Perhaps we have been fortunate in being confronted less frequently with this problem. At any rate, we have been singularly unsuccessful in dealing with it.

Table IX reveals the influence exerted by anomalous correspondence on the functional result. Only 9.4 percent of our cases developed postoperative fusion, even with the aid of orthoptic training, as against the 31.9 percent of 248 cases which had normal correspondence when first seen. Our routine treatment of cases presenting this problem consists, first, in preventing binocularity by constant and full occlu-

TABLE VIII

EFFECT OF VERTICAL COMPONENT ON RESULTS OF THERAPY IN CASES OF NONACCOMMODATIVE COMITANT ESOTROPIA

VERTICAL COMPONENT	NO. OF CASES	FUNCTIONAL CURE		COSMETIC IMPROVEMENT ONLY	
		NUMBER	PERCENTAGE	NUMBER	PERCENTAGE
Present	66	5	7.8	61	92.2
Absent	267	82	30.8	185	69.2
All cases	333	87	26.1	246	73.9

TABLE IX

EFFECT OF PREOPERATIVE STATUS OF RETINAL CORRESPONDENCE ON RESULTS OF THERAPY IN CASES OF COMITANT ESOTROPIA

PREOPERATIVE STATUS	NO. OF CASES	FUNCTIONAL CURE				COSMETIC IMPROVEMENT ONLY		
		SURGERY ONLY	SURGERY & OCCLUSION ONLY	SURGERY, OCCLUSION & ORTHOPTICS	PERCENTAGE OF CASES	SURGERY ONLY	SURGERY & ORTHOPTICS (PREOPERATIVE & POSTOPERATIVE)	PERCENTAGE OF CASES
ARC	85	0	3	5	9.4	15	62	90.6
NRC	248	38	0	41	31.9	126	43	68.1
Total	333	38	3	46	26.1	141	105	73.9

sion, either of the amblyopic eye in monocular squinters or of each eye, in turn, in alternators. To patients old enough for orthoptic training, preoperative exercises are given in the office, using standard techniques. But if no improvement is noted after four or five visits, no further attempt at preoperative training is made. We believe that proper surgical alignment of the eyes will result in binocular stimulation of the maculas as readily as will any preoperative training. Normal retinal correspondence may not be an immediate result of surgery, however, and frequently several months will go by before normal correspondence can be demonstrated. In most cases, postoperative training is helpful. When surgery does not result in complete alignment of the visual axes, occlusion should be continued until further surgical correction is made.

We were able to restore normal correspondence in 30 patients of the 85 who exhibited anomalous correspondence when first examined. One half of these were successfully treated by preoperative occlusion and bifoveal stimulation, and showed normal correspondence at the time of operation. In spite of this, only four obtained a functional improvement. Thirteen cases did not respond to preoperative orthoptics, but they developed normal correspondence postoperatively without benefit of further training. There is no reason to believe, therefore, that preoperative orthoptic training for anomalous correspondence increases the percentage of patients in whom normal correspondence is restored. It is significant, we think, that even when normal correspondence is restored, by either orthoptics or surgery or both, the fusional results are disappointing. It is, nevertheless, apparent that unless normal correspondence is restored, we are doomed to failure.

There is no reason to believe that failure to restore normal correspondence will result in failure to restore ocular alignment. The statement has frequently been

made that patients with anomalous correspondence tend to revert to the preoperative angle of deviation. This is not so. We had 55 cases in which anomalous correspondence was not abolished by either orthoptic training or surgery or both. In only 9 of these was the angle of deviation unchanged by surgery, and all of these were small-angle tropias. Fifteen cases showed a marked reduction of the angle of deviation, and 29 cases were rendered cosmetically straight. Two cases showed a consecutive divergence postoperatively. This would seem to prove that the presence of anomalous retinal correspondence is not a bar to cosmetic cure.

Eighteen years ago, when orthoptics was beginning to enjoy its present phase of popularity, there was a widespread feeling among ophthalmologists of our acquaintance that orthoptic training could reduce or eliminate the necessity for muscle surgery in many cases. This was an excusable, but unfortunately erroneous, belief. We know now that with the exception of accommodative esotropia and a few instances of small angle intermittent exotropia of the divergence excess type, orthoptics alone will not overcome a deviation; only surgery can do it. Preoperative orthoptic training frequently can, however, provide an adequate sensory background, so that when the proper functional background is provided by surgery, normal binocular vision has a better chance to develop. Postoperative orthoptic training should aim at aiding this development.

SUMMARY

The success of orthoptic training depends on several things:

1. The patient must be young enough so that re-education of the distorted binocular reflexes is still possible.

2. The patient must have had some normal binocular experience before the onset of the squint (this implies, onset after the child is two years of age).

3. The patient must be old enough to have an adequate attention span. He must be able to recognize progress and to gain some satisfaction from it.

These three circumstances prevailing, orthoptics can prevent the development of certain adaptive mechanisms or break them down if they have already developed, thus restoring the sensory background for normal binocularity. Conversely, orthoptics is of slight value in patients first seen a long time after the onset of a constant squint, and it is of little value in patients with early onset of squint because of the great length of time between the age at onset and the age at which orthoptic treatment may be effective.

The percentage of functional cures is higher when surgery is performed early. In comitant convergence strabismus surgery before the age of 6 years results in good function. After 6, functional cures following surgery are attained in most cases only with the aid of orthoptic training; the older the patient, the less chance of success, whether orthoptic training is utilized or not. Comitant divergent strabismus may be cured functionally at any age, and there seems to be no reason for urging early operation for fusional purposes alone. Other factors, such as psychological trauma, increase in exotropia with time owing to an increasingly divergent position of the orbits, or a lessening of accommodational tone, may justify early surgery in those cases which do not respond to orthoptics. Surgery should be done as soon as it is apparent that the exotropia is becoming constant.

When surgery is performed, the goal should always be proper alignment of the visual axes without incomitance and without impairment of convergence ability. For this reason, surgery is best done symmetrically, and great care should be exercised in recessing the medial recti when there is a poor convergence near point. In order to bring the eyes into alignment, the amount of surgery to be done should

be planned carefully, and consideration should be given in advance to the age of the patient, the age at onset, and the amount, variability, and intermittency of the squint measurements. In the last analysis, success in the treatment of nonaccommodative comitant strabismus depends on adequate and complete cooperation between the ophthalmologist and the orthoptic technician, the former correcting the deviation and the latter providing the necessary sensory background on which fusion may be built. Given an otherwise healthy, intelligent and cooperative patient, failure to cure a squint satisfactorily is due either to the surgeon's failure to abolish the deviation, horizontal or vertical, or to the failure of the orthoptist in helping the patient to overcome anomalous correspondence and amblyopia. In this, as in any task worth doing, there is no substitute for experience. Success, it will be found, is concomitant with adequate diagnosis and proper treatment.

Symposium: Surgery and Orthoptics

PREOPERATIVE AND POSTOPERATIVE ORTHOPTICS

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THE sensory symptoms of a patient with strabismus are diplopia and visual confusion leading to suppression, amblyopia, and anomalous correspondence. An orthoptic analysis should determine how the patient has adapted himself to the motor and sensory changes resulting from these defects in vision. It is then the aim of orthoptic training to obtain the best possible use of the two eyes by attempting to overcome these sensory adaptations.

The first step toward a successful result by preoperative and postoperative training is the careful selection of cases. To assume that every strabismic patient should have orthoptic training is a mistake and will merely lead to the accumulation of orthoptic records that show very few cases of improved vision.

If it is found that a patient is unlikely to acquire comfortable binocular vision, comfortable monocular vision should not be disturbed. Further orthoptic treatment should not be undertaken.

In order to select a case for orthoptic training, an analysis of the patient's aptitude and his attitude toward his problem must be considered. His personality, maturity, ability to observe and respond accurately, and his medical and psychological problems play an important role in the final results. These factors are often neglected because they are not directly ophthalmological. Of the ophthalmologic factors, age at onset, type of deviation, family history of strabismus, and previous treatment and its effectiveness are important in outlining the training.

All of the above factors must be favorable, for binocular skills and fusion habits, when not learned normally at reflex level, require a great deal of work to learn by orthoptic training alone.

Preoperative training is planned for the purpose of establishing normal visual habits. Its function is to overcome amblyopia ex anopsia, to develop steady monocular fixation with each eye, to eliminate suppression, to make the patient aware of diplopia, and finally to develop fusional amplitudes.

It is of primary importance to eliminate amblyopia. Equal visual acuity is essential to normal binocular vision. The orthoptic technician may be delegated to supervise this treatment, which usually starts with some form of occlusion of the fixing eye. Explaining the purpose of occlusion to the patient often helps with the selection and adjustment of a suitable method of occlusion. While total occlusion appears to be most effective, it cannot be used on all cases. Necessity has brought about the use of other forms of occlusion, such as atropine, lens occlusion, the combination of atropine and lens occlusion, atropine in the fixating eye and di-isopropil fluorophosphate 0.025 percent (floropryl, DFP) in the amblyopic eye.

The upper age limit at which occlusion is attempted will depend on many factors. Such information as sensory adaptation, past history of occlusion, amount of amblyopia present and the patient's coopera-

Read at the Annual Joint Meeting of the American Orthoptic Council and the American Association of Orthoptic Technicians, Sept. 19, 1954, New York, N. Y.

tion are taken into consideration. The length of time to continue occlusion varies, but one or two months of *complete* occlusion without any improvement in visual acuity is enough; if the visual acuity has failed to improve, it probably indicates an eccentric fixation which will not respond to occlusion but will require elaborate visual training such as that at Dr. Bangerter's Pleoptic School. Occlusion should be carried out just so long as there is improvement. If improvement is slight due to poor cooperation, other forms of occlusion should be attempted. Treatment of amblyopia can be enhanced by monocular home training with such devices as television, reading, tracing, dart games, beading, and puzzles. When the visual acuity has improved to within two or three lines of the acuity of the other eye, full-time occlusion may be replaced with lens occlusion, such as obtained with permafilm, either monocular or alternating. Occlusion is continued to the time of surgery. There should be no halfway treatment regarding amblyopia. Nearly equal vision is not sufficient if a functional result is the goal.

When the acuity is nearly equal, the sensorial status is re-evaluated. If normal correspondence is present, binocular home training may be started. For example, one of the home training exercises includes watching television, reading, or tracing with a red pencil while wearing a red clip over the fixing eye. The patient must make a conscious effort to use the amblyopic eye. This conscious effort to use the amblyopic eye aids also in altering the fixation pattern.

To increase the chances of a good functional result, stabilization of the fixation pattern is necessary before surgery. Normal fusion cannot take place if fixation with each eye does not exist. Frequently occlusion alone is not enough to change the fixation pattern and must be supplemented by fixation training.

Fixation exercises should be done at home by the patient with the assistance of the parents; progress should be checked at the orthoptic clinic. The type of fixation pattern is classified as follows: (1) *fix*: unsteady fixation with the other eye on cover-uncover test; (2) *strong preference*: the patient holds fixation momentarily with the other eye; (3) *prefers*: the patient holds fixation with the other eye when the cover is removed; and (4) *alternates but prefers*: the patient is able to alternate at will with just a preference.

When step four has been attained, diplopia exercises are in order.

Diplopia training should only be given to selected training cases. It will depend largely on the sensorial findings and the age of the patient. If there is no likelihood of attaining a functional result, the patient has nothing to gain by learning when he makes binocular errors. Diplopia should be taught to patients who have normal retinal correspondence with some fusional ability under clinical testing conditions. It is essential that the patient be aware of diplopia with either eye fixing. Diplopia is often elicited with the nonfixing eye, but it is more difficult to obtain with the habitually fixing eye. The purpose of diplopia exercises should be explained to the patient. It will help the patient to recognize when he makes fusional errors.

Training should be started on the major amblyoscope while continuing occlusion for amblyopia, fixation and diplopia exercises. The major amblyoscope is used to eliminate suppression and to reawaken and stimulate the fusion mechanism. Fusional experience should be made easy for the patient by using targets of the proper size. To elicit diplopia off the machine does not always mean that suppression has been completely eliminated. Although the patient experiences bifoveal fixation, suppression may still occur. This may be demonstrated by using central fusion targets or when stimulating vergences even when no suppression is found with larger targets. Antisuppression exercises, such as

chasing or flashing, or the use of the Walraven technique is helpful in the elimination of suppression on the major amblyoscope. Some form of occlusion and home training should be given to aid in the elimination of suppression.

Once this is accomplished, divergence and convergence amplitude training should gradually be given to the patient. Preoperatively, convergence is stressed with esotropias but not exotropias. Fusional amplitudes are important in the maintenance of fusion for casual seeing. When an object is moved so that images fall on disparate retinal elements, fusional movements are necessary to correct the relative position of the eyes and bring the image again on to corresponding retinal elements. A patient who merely learns to fuse at a given distance will be unable to make the necessary adjustments for various distances unless he has adequate fusional amplitudes.

Once peripheral fusion is established, the size of the targets on the major amblyoscope should be decreased. Home training techniques will depend on the amount of the deviation. If the patient has a moderate or large esotropia, fusion training is difficult except at near. Patients with intermittent strabismus should practice fusion and diplopia exercises with the various home training techniques.

The time given to preoperative orthoptics varies with the patient and with the clinical findings. Ideally, one would like all strabismus cases to reach the point where the patient experiences fusion with some degree of fusional amplitude. If, during the course of training, an obstacle of one sort or another prevents further progress, surgery should not be further delayed.

The child should be given some idea of what the surgical intervention entails. A simple explanation by the ophthalmologist or orthoptist is often very helpful. In many cases the patient will look forward to the event after he knows the purpose of the operation.

Up to this point, preoperative training in cases of anomalous correspondence has been omitted. The previous discussion has applied to patients with normal correspondence. Some orthoptists continue to treat many cases of anomalous correspondence, and others rarely treat them at all. I believe that we at the Presbyterian Medical Center fall into the latter group.

If the patient has equal visual acuity and steady fixation, with the orthoptic examination revealing anomalous correspondence, surgery is not delayed for further orthoptic treatment. After surgery the orthoptic examination is repeated. If anomalous correspondence appears to be unstable, treatment may be undertaken. However, there is one type of anomalous correspondence that is given preoperative care, namely, that in patients between the ages of 4 and 6 which shows the following characteristics: (1) equal visual acuity with the E test, (2) unstable fixation of the deviated eye on cover-uncover test and (3) deep suppression with a possible anomalous correspondence. Full-time occlusion and fixation exercises are prescribed. If possible, an attempt is made to teach the child numbers or letters. If the visual acuity is tested with numbers or letters, there may be good visual acuity in the fixing eye and an amblyopia in the other eye of three to four lines. With the elimination of amblyopia and a steady fixation pattern established, re-evaluation of the sensorial status may show normal correspondence with only some degree of suppression around the objective angle. This type of anomalous correspondence may be long on treatment and short on results if one does not believe in occlusion for anomalous correspondence.

Just as the aim of preoperative treatment is to establish normal visual habits, the postoperative treatment is aimed at stabilizing these visual habits so as to develop steady fusional control. After surgery the

sensory and motor apparatus is undergoing a readjustment. Much can be done for the patient at this pliable stage. Postoperative training should be undertaken as soon as the patient can move his eyes comfortably. The time element will depend upon the surgical procedure. Within one or two weeks most patients are able to start orthoptic training. If there is a delay in orthoptic treatment of two or more months after surgery, a new sensorial adaptation may have developed. The patient may be unable to take advantage of the new ocular alignment and may lapse back into his old preoperative sensory adaptations rather than develop normal fusion.

Orthoptic training should be intensive at this period. Antisuppression exercises and fusional vergences on the major amblyoscope are stressed. The patient is seen three times a week. Home training is started immediately, for example, recession exercises, physiologic diplopia, bar reading, Walraven bar separator, and, when available, poloroid television.

Office visits are decreased depending upon the progress and ability of the patient to maintain steady binocular vision when he is not using the various instruments. Home training is gradually decreased. At this stage occasional checkups are essential to see that the successful result is maintained. In this way, if there is any indication that the patient is reverting to bad visual habits, a refresher course may be given.

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SURGERY FOR STRABISMUS

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BY INVITATION

DULL would he be of soul who could stand here and not recall those to whom we owe so much. We think of Alexander Duane and Stevens and James Watson White of this city, of Bielschowsky of Breslau and Dartmouth, of Lucien Howe of Boston, and of others.

With admiration and sorrow we remember Walter B. Lancaster—so rich in many years—and Richard Scobee—so rich in few—and yet so alike in enthusiasm, honesty and clearness of vision.

Many are here to whom I am indebted. As I proceed to construct my talk you will see that they (and you) have made many of the bricks with which I build.

Disordered Optomotor Reflexes and the Surgery of Strabismus

Instead of considering binocular vision, may we attempt to understand, first, a certain lack of integrity of those optomotor reflexes that underlie binocular vision and, then, the need for surgery.

AMBLYOPIA EX ANOPSIA

The prevention of amblyopia is our most vital task. Amblyopia is secondary or tertiary in origin but primary in importance. There is no worse blot on the escutcheon of Ophthalmology than the prevalance of amblyopia. Downing's finding (1945) that 66 per cent of all young men with unilocular visual loss suffered from amblyopia shows that the United States shares this defect with us. The records of 350 private patients with convergent squint, with follow-up until they could read, showed that 24 per cent had vision of 6/18 (20/60) or less in one eye. Of those with onset of squint before 2 years of age, my orthoptist considers that only 10 per cent had received adequate occlusion by the age of 4, and of those with squint arising between 2 and 4 years, only 20 per cent by the age of 6 years. One problem is the relatively late age at which advice was sought. The average age at onset for 352 patients with convergent strabismus was 2.14 years. But the average age at which they first reached me was 5.7 years.

PRIMARY DEFECT		SECONDARY CHANGES	TERTIARY CHANGES
Disorder of optomotor reflexes underlying development and maintenance of binocular vision	Deviations	Alternating hyperphoria Nystagmus Strabismus	Muscle hypertrophy Oblique imbalance Amblyopia and suppression Anomalous correspondence

Read at the Annual Joint Meeting of the American Orthoptic Council and the American Association of Orthoptic Technicians, Sept. 19, 1954, New York, N. Y.

Only 12 per cent of squints arising before the age of 3 years develop 6/6 vision if they have squinted over half of their lives (Lyle, 1950). In old age we strain at 6/9, and in infancy we swallow 6/60.

It is unwise to assume that macular lesion's are present. "At least 93 per cent of squinters, regardless of onset, can develop 6/6 if treated before the squint has lasted less than one-eighth of life."* Keiner, 1951, wrote, "In all patients under 6 years the amblyopia was seen to improve, even in cases in which it had probably developed before the first birthday."

It is untrue to say "a child cannot gain vision it never had." Because a squint arose at 1 year, can we anticipate only 6/26 vision? We do not know when suppression arose. Keiner found greater visual acuity in young children than we usually recognize, for example: "A value of 5/5 is no exception at the age of 4 years." We should be encouraged by Bangerter's work published in 1953. The thoroughness of occlusion and the exercise of the uncovered eye are essential. Conscious use of the amblyopic eye is at times more important than the completeness of the occlusion. Is there special value in the method of Fritz, 1952, or the temporal occlusion of Swenson, 1953? Can our prognosis be guided by the characteristics of the scotoma, the improvement with a telescopic magnifier (Kasser and Feldman, 1953), or the perception of Haidinger's brushes, or the Maxwell spot, or Brock and Givner's test (1952) or Burian's (1954) tests?

If the squint is present at or soon after birth, we instill atropine in the fixing eye to reverse the squint until refraction is possible. Then glasses are worn and alternating fixation sought by occlusion, if necessary. Not infrequently we prefer operation even in the second year once good alternate fixation has been secured. Rarely do we operate before this is obtained, and then we may be worried by fear that one eye is not being used. The mother's observations on effects of alternate occlusion are then useful as a guide. If after prolonged occlusion we cannot obtain reversal of the squint and good fixation, we seek a slight undercorrection by operation, especially if a large positive angle kappa is present. There may be a possibility of divergence in the second or third decade, but further operation is preferable to an unsightly deviation throughout the early years of school life.

And what of drift in amblyopic cases? It appears that "little or no drift" was only half as common in amblyopic cases as in others. Among those that drifted, there was a greater frequency of divergence in the second decade than between the fifth and tenth year after operation. (Anderson, 1950).

The equality of vision in the two eyes appears of great value in the completion of a cure. Not only was a drift greater, but no cure was found if "heteropia" or a difference in visual acuity of from two to four rows of Snellen's test existed. Orthoptics—too much, too early—has been a fault in the past, in my experience, but occlusion —too little and too late— sums up the greatest error in my treatment of strabismus. Next in importance comes inadequate correction of hypermetropic errors.

ACCOMMODATIVE SQUINT

As this meeting is international, may I ask, "Is our problem yours?" If amblyopia is an international problem, is the accommodative type of strabismus national? Oculists from the old civilizations, China, Japan, Arabia, and Indonesia, are less worried by convergent strabismus than we are. Is it adequate to say, "Oh yes, it is racial"? Why is it racial? The genes are different. But should we also contrast their old civilizations, the concentrated near work, and the different diet in the Far East with those of Europe? Does this explain the four times greater frequency of myopia in these nations than in Europe

*This statement by Worth is not significant unless we exclude accommodative squint.

and North America? The varying incidence of refractive errors is difficult to estimate. It varies in different types of practice. The ratio of hypermetropia and hypermetropic astigmatism to myopia and myopic astigmatism in one practice in Spain was 1 to 7, in Italy was 1 to 2.5, in England was 5 to 1, and in the United States was 7 to 12. If I consider my nonpresbyopic patients who receive glasses for errors over 0.5 diopters, the ratio in my practice is 7 hypermetropes to 6 myopes. Of course a smaller proportion of low hypermetropes than of low myopes obtain glasses.

Four out of every 5 convergent squinters are hypermetropic; only 4 out of every 100 are myopics. Approximate estimates of strabismus among school children are: Spain, 0.2 to 0.8 per cent; Italy, 1.35 per cent (among 1,700 children aged 7 years, Bietti); England, 3.07 per cent aged 5 to 6 years (Lyle, 1950); United States, 2.35 per cent; and Australia, 2.8 per cent among 22,189 children in Victorian State Schools. Then in order to eradicate strabismus must we remove hypermetropia? How can we do this? Alabaster considers it to be a dietary problem.

It appears that various customs in Japan lessen the incidence of strabismus. These make for peace and security throughout the first decade. The opposite states follow the ravages of harassed motherhood and of the economic idolatries all too common in our way of life.

In the present series of nonamblyopic convergent squinters, 15 per cent were purely accommodative; that is, convex lenses reduced the angle by at least 75 per cent. In 28 per cent the angle was reduced from 50 to 25 per cent, and in 57 per cent by less than 25 per cent.

In the past, one of my errors was undercorrection of hypermetropia. Now I order full correction, subtracting only one diopter from retinoscopy findings or lenses that make the eyes parallel. It is a help if spectacles can be obtained before atropine ceases to act. It is wise to remeasure the angle with additional spheres. Scobee, 1949, wrote, "A full correction means the entire refractive error, as found under atropine cycloplegia" and "What appears to be a full correction is usually an undercorrection by an amount equal to the incompleteness of the cycloplegia." He used ointment and not drops! Vaughton and Stewart's emphasis in 1950 on this point is very valuable. A baby's world is very small and its visual needs largely at arm's length. Therefore it requires greater accommodation and convergence than does a child at the age of six years.

This is our essential introduction to orthoptics, for the problems presented vary greatly with the adequacy of the glasses to give the ciliary muscles no more, or even less, than normal work. With full correction the cure may be automatic. With partial correction, however, the whole range of adjustments, including suppression and anomalous correspondence, may develop. These cases require treatment that varies in length with the age at onset of the squint, the interval of time without glasses, the nature of the child, and the home and school background.

Patients wearing spectacles which fully correct their refractive errors are watched carefully. Once binocular vision is firmly established, we weaken the correction, seeking the weakest glasses that permit parallelism of the visual axes and freedom from symptoms. The patient is encouraged to hold his eyes straight without glasses—"misty" and "clear"—in the hope that glasses may be abandoned, at least for distance vision.

Nothing simplifies future treatment as much as early and full correction with glasses. The preventive value of early full correction of refractive errors far outweighs the partial curative effect of stronger glasses ordered later. Guibor (1934) found 30 per cent of all patients with concomitant squints with straight eyes after one year's treatment with spectacles and occlusion alone. Luhr (1954) considered that

very few accommodative esotropes required orthoptics. Can we dispense, then, with therapeutic orthoptics, as has been suggested? I think not, for the range of fusion, of accommodation, and of motility may be improved. More important, perhaps, is the control of squint without glasses, so encouraging to patients and to parents. This may follow orthoptics, and whether we advise it or not, glasses will be abandoned by many in adolescence. The orthoptist is encouraged to try the effect of stronger spheres or altered cylindrical axes. Diana Mann finds that removal of suppression of the squinting eye on accommodation, or of an inability to fix, may lessen the deviation and obviate an operation.

NOTE: It is desirable to have further information on Abraham's (1952) and Huber's (1954) advice to produce peripheral accommodation without convergence by miotics. We should consider also Stewart and Vaughton's (1952) treatment of overaccommodation in near vision of the squinting eye. They attribute amblyopia that readily improves and the reading difficulty of the squinting eye in abnormal correspondence to this cause. For training, they use a synoptophore without lenses at 14 centimeters.

When do we operate in accommodative squint?

It is essential to emphasize the vital difference between the effects of full and of partial correction of the deviation with glasses. If the deviation is completely corrected, operation is delayed until it is certain that glasses will not be necessary for near work. If the deviation is only partially corrected and is a cosmetic handicap, and the child is too young for orthoptics, recession of one or both internal rectus muscles may be carried out. The result of a cover test for distance, with prism measurement, should guide us when considering the angle to correct by operation. Concentration on small objects in a cover test at 18 inches may reveal a convergence excess which may require stronger spheres, bifocals, or a recession of one or both internal rectus muscles. Operation, however, will be considered shortly.

The correction of hypermetropia has such a profound effect on this type of strabismus that we are justified in calling it the accommodative type. But as 92 per cent of hypermetropes do not squint, and as 4 per cent of squinters are myopic, we must seek a contributory factor in the partially accommodative type and the fundamental factor in the remainder.

THE NONACCOMMODATIVE TYPES

Let us now consider the causes of squint in which the deviation is reduced by glasses by less than 75 per cent. Let us not be bound by hard and fast lines, because many have mixed and variable features. Costenbader divides these deviations into two groups, the tonic group and the mechanical group. Deviations of the former group disappear under deep general anesthesia, while the latter remain little changed. In contrast with the accommodative type, the onset tends to be earlier, while constancy, faulty retinal relationship, associated vertical deviations and amblyopia are more common.

The frequency of vertical defects suggests a mechanical origin for at least one extreme group. A vertical deviation of at least 5 prism diopters or evidence of muscular underaction or overaction was found in 30 per cent of the purely accommodative group (40 cases), in 43 per cent of the partly accommodative group (75 cases), and 59 per cent of the nonaccommodative group (151 cases).

What are the missing factors that cause these squints?

The great essential when considering treatment is to estimate in each case the influence of innervational and of structural factors.

Abnormal Innervation

Bielschowsky's emphasis on abnormal convergence innervations has been reinforced by Adler's views. These observers picture the seat of the disturbance in the subcortical centers and pathways. Support

was claimed from the fact that convergence follows early anoxia in general anesthesia and also in alcohol poisoning. The convergence mechanism is set at too high a pitch (Adler 1950). But why? The tendency to look for a supranuclear origin has been greatly encouraged by Keiner's report. He considered that there is a period in infancy during which eye movements are dissociated and Hering's law is not applicable. Monocular reflexes are in control, and those causing adduction dominate those for abduction and conjugate movements. Retarded and irregular myelination could account for this. The initial cause, he thinks, could be a disturbance of the fetal or postnatal endocrine systems. Could deficient oxygenation just before or during birth be responsible?

The convergence which develops prevents the establishment of binocular vision. The higher binocular reflexes superimposed upon binocular visual junction cannot develop. The reflex chain, beginning with peripheral fusion reflexes and ending with those of central fixation, is also unable to develop. It is significant that Keiner found adduction on temporal stimulation, up to the thirteenth year, of children whose eyes had become straight and also in nonsquinting members of a squinting family.

When do we operate on these nonaccommodative squints? Certain complications influence this decision. We have considered amblyopia, let us now consider anomalous interretinal relationships.

Interretinal Relationships.

The lack of correspondence in the ideas of various authors is as marked as is the lack of correspondence in nonaccommodative squints. (Even Burian has been unable to produce completely harmonious relationships in these spheres!)

NOTE: There is not even agreement about the title "anomalous interretinal relationship." "False projection" is unsatisfactory: (1) it conjures up a picture of egocentric localization in space as in recent palsies; (2) in abnormal correspondence the projection of the images of both eyes is true (Swan, 1950); (3) retinal points cannot be projected, but only visual impressions, and even they are localized subjectively (Burian). If retinal correspondence has an unalterable inborn foundation, can it be abnormal? Keiner, therefore, prefers the conception and the title "binocular junction," normal or abnormal, of the homonymous halves of the retinas (Keiner, 1951).

Anomalous retinal correspondence may be said to exist when the foveas have not a common visual direction or when one fovea and a normally disparate area of the other retina share a visual direction. This state may be partial or complete. If we cannot obtain unanimity among authors, fewer problems would arise if we would specify the meaning they attach to "abnormal correspondence." In addition, the test used should be stated, for many patients who show an absence of (normal) correspondence on the synoptophore give a normal reaction with the double-image test. Some who show normality with the after-image test show abnormality with other tests.

In this paper, ARC refers to anomalous retinal correspondence, usually as found with the synoptophore, and unfortunately includes (1) absent correspondence (or loss of normal retinal correspondence or complete suppression) and (2) abnormal correspondence (anomalous correspondence and abnormal projection are terms used by other authors). The available information did not permit accurate diagnosis in all cases, and usually when correspondence was "absent," the double-image and after-image tests were not carried out.

It is recognized now that we cannot say "absent NRC" (normal retinal correspondence) simply on synoptophore evidence, for other tests may reveal it. The important finding is that made in the test the conditions of which resemble most closely those of normal seeing. Maisie Levinge (1954) suggests that all anomalous cases may show a harmonious relationship if "investigations duplicate the usual visual conditions." The diagnosis "ARC" is meaningless unless the nature of the test is revealed. As a rule the faulty interretinal relation-

ships are not as fixed, hard and fast as we have thought. There is a plasticity that permits variable results under different conditions, with different tests and with either eye. The more closely the conditions of the tests resemble those of ordinary seeing, the more the adaptation of abnormal binocular function is revealed (Burian).

Whether we decry the abnormal relationship and call it "quasi" (Verhoeff) or value it highly as an acquisition, with Levinge, depends partly on the tests we use. The latter author found it accompanied by stereoscopic vision, when using the numbers test in over 50 per cent, and by physiological diplopia in 62 per cent of her series. In addition, the periphery of the retina is now claiming greater attention and the significance of its primitive role is recalled. While the greater acuity of the central region leads to confusion and subsequent suppression, there is conflict in the sensations of direction from the periphery of the binocular fields. The attempts at integration lead to the various forms of abnormal sensory relationships (Swan 1950).

While suppression, or even amblyopia, may affect the form sense of the new corresponding area, its sensations of direction may act at a physiological, if not at a psychological, level.

Realization of the different functions of the macula and the surrounding retina has led to greater use in training of the superiority of parafoveal fusion (Keiner 1951; Posner and Schlossman 1951). If both areas are stimulated simultaneously, the latter will dominate the foveal region if any disparity exists (Swan 1950).

Synoptophore findings are not always easy to interpret; for example, a fusion range of 40 degrees with good stereopsis to the usual slides, yet the lion disappears behind the cage. Such findings drive us back to physiology. Can we think of the primitive fixation reflex as an essential response to light stimulation and characteristic of the periphery? Then can we consider the motor part of fusion as a reflex initiated by disparity of identical points in the periphery but most strongly developed in the parafoveal region? If so, is not stereopsis, or the highest form of binocular vision, simply the sensory part of fusion—the inevitable perception following the reflex movements that permits, other things being equal, the epicritic centers for form, color and fine discrimination to subserve their function as corresponding points? Is it wise to say that normal correspondence is inborn? Surely it is the anatomical framework for or the capacity to develop normal correspondence that is inborn. Its establishment requires the stimulus of light. A deviation can so influence indirectly the synaptic thresholds that by facilitating some impulses and impeding other impulses, abnormal use of the extensive and still plastic occipital arborization may be made.

In the past we have often had inaccurate information. The surgeon's impression of the orthoptist's opinion of the child's interpretation of a somewhat confused state is not enough!

A not uncommon condition in which sometimes correspondence is normal and sometimes not, that can be designated "NC =AC," does not appear in some analyses. Beverly Balfour has found it singularly persistent.

Let us consider the influence of angle, age at onset, duration and constancy of strabismus on the development of normal relationships (tables I-III). It is suggested that the separation of constant from intermittent squints is essential in these analyses, and the failure to make such a division has been a cause of faulty conclusions in certain previous reports. Regardless of angle, abnormal retinal relationships were found in only 1 of 31 intermittent squints (3 per cent) and in 76 of 104 constant squints (73 per cent). Those with NC=AC occurred in 4 per cent and 10 per cent of the respective group. Without

TABLE I

INFLUENCE OF ANGLE ON RETINAL RELATIONSHIP IN NONAMBLYOPIC, NONACCOMMODATIVE CONVERGENT STRABISMUS

A. Intermittent Cases

ANGLE	NUMBER OF CASES	RELATIONSHIP NORMAL	RELATIONSHIP ABNORMAL	NC = AC
less than 10 degrees	6	6	0	0
less than 20 degrees	14	12	1	1
less than 30 degrees	6	6	0	0
more than 30 degrees	2	2	0	0
Total	28	26	1	1

B. Constant Cases

ANGLE	NUMBER OF CASES	NORMAL	RELATIONSHIP ABNORMAL	NC = AC
less than 10 degrees	4	0	3	1
less than 20 degrees	23	7	14	2
less than 30 degrees	42	7	31	4
more than 30 degrees	33	2	28	3
Total	102	16	76	10

The angle of deviation appears to have little influence on interretinal relationships in these small series.

TABLE II

INFLUENCE OF AGE AT ONSET OF CONSTANT, NONAMBLYOPIC AND NONACCOMMODATIVE STRABISMUS

AGE AT ONSET	NUMBER OF CASES	ABNORMAL RELATIONSHIP PERCENTAGE
Birth to 6 months	41	95
6 months to 2 years	24	77*
2 years to 4 years	25	56*
4 years and over	15	6*

*Many probably had earlier origin than parents realized.

TABLE III

INFLUENCE OF DURATION OF CONSTANT NONAMBLYOPIC, NONACCOMMODATIVE STRABISMUS

DURATION*	NUMBER OF CASES	ABNORMAL RELATIONSHIP PERCENTAGE		NORMAL RELATIONSHIP AT LAST VISIT
		FIRST VISIT	LAST VISIT	PERCENTAGE
6 months to 5 years	10	30	20	60
5 to 10 years	21	70	20 (24% were NC—AC)	57
10 to 20 years	34	58	53	38
20 years and over	26	90	80	17

*Duration here refers to the duration of squint rather than to the period of its constancy. The latter, as a rule, would be shorter and is difficult to ascertain.

doubt, the essential condition for the prevention of normal correspondence and for the emergence of the abnormal correspondence is the constancy of deviation.

Now when and how do we operate in these cases and what are the results?

Time of Operation

Operation is not considered, nor is orthoptics continued, until every effort has been made to improve the general health of the patient and, if necessary, to try to overcome any psychological maladjustment that may exist at home or at school. Diana Mann and Beverly Balfour prefer to delay training for ARC until the seventh year. If the deviation is partially accommodative or nonaccommodative in type and the child too young for orthoptics, we may operate in the second year. The age for orthoptics may depend on the type of child, the attitude of the parents and the ability of the orthoptist.

Operation at this early age is not carried out unless (1) the angle is over 15 degrees; (2) the deviation is constant and reported never to be absent; (3) alternate fixation is present or a serious effort made to establish it and the effect of alternate occlusion observed; (4) hypermetropia has been fully corrected and astigmatism has been accurately corrected for three to six

months; and (5) an attempt has been made to correct the defects in home setting and general health. It is wise to obtain the confidence of both parents.

Recessions of the internal rectus muscles are preferred to resections of the external rectus muscles though, of course, both may be required. As we seek symmetry, it is unwise to operate too much on one eye. It is better to leave a small squint untreated by surgery than to overcorrect it.

We should also consider the following facts:

1. The angle to be corrected is that found in distance vision measured with prisms when the patient is relaxed. This, of course, is impossible to obtain in many young patients.
2. The passing years influence accommodation.
3. An operation in early life has a greater effect than in later life.
4. An operation on horizontal muscles may affect a vertical deviation and vice versa. The vertical deviations that are transient, however, are often the secondary ones that appear later in life.

If the child is old enough for orthoptics, we postpone surgical procedures to allow for a period of orthoptic training, while we consider the constancy of the size of the deviation, the retinal relationship and the ability to fuse. If progress is slow, and if the angle is at least 15 degrees and constant and the correspondence remains abnormal, and if full correction is being worn, we advise surgery.

If the chance of obtaining stereoscopic vision is remote and if the advantage of such a gain to a particular patient is slight, we do not persist with orthoptic training. This applies particularly to children of 12 years or even less, because we do not wish to risk the danger of permanent diplopia.

In spite of correspondence being normal, orthoptic treatment ceases when findings suggest an inability to fuse; for example, constant postoperative diplopia when the angle is less than 5 degrees, poor superimposition of fusion pictures when simultaneous macular perception is present, when fusion is attempted at an angle greater than the objective angle, or when there is no fusional range (Lyle, 1953). It is the presence of fusion, even though correspondence is abnormal with simultaneous macular perception pictures, that is so desirable before operation. If the lion persist in disappearing at an anomalous angle, we do not continue orthoptic treatment. But if there are signs of normal relationship, we do. Burian emphasizes the tendency to permanence of faults if they are revealed by both synoptophore and after-image tests. Our experience supported this view but revealed unexpected differences in the results.

Does the presence of either bimacular superimposition or macular-comacular separation justify an optimism that the presence of bimacular separation with macular-comacular superimposition forbids? (Pascal, 1952.)

Julia Lancaster has found that when a patient evidences an inability to fit targets after half an hour's rapid oscillation, at least a hundred visits are usually required for correction. Under what circumstances would the demands of such treatment be justified?

Operation is not advised for small convergent angles when correspondence is harmonious, or almost so.

When Sheila Mayou finds that suppression is present when using her foveal slides, she expects to obtain binocular vision in three visits, but she is very pessimistic if true abnormal correspondence is present. If this fault is revealed when using the small square target, she advises against operation. Shepherd, 1951, finds that a small residual angle tends to return after operation if abnormal retinal relationship is present. Similar pessimism affects orthoptists in Australia. Is it justified?

It has been claimed that anomalous correspondence can and has upset the results of operation. In my experience I believe that other causes are responsible for drift. Indeed, I find it difficult to understand that such a power can be exerted by faulty correspondence. If it is, surely at times we would expect a change in angle when correspondence become normal. Evidence on this point would be valuable. Certainly, in my series marked drift was more common when correspondence was anomalous than when normal. This was attributed, however, to the beneficial effect of the latter, permitting fusion, rather than to the deleterious effect of the former. Great drift was twice as common, and little or no drift was almost one third as common, when correspondence was anomalous as when it was normal. But was the drift more towards the original angle and less away from it than in patients with a normal correspondence? In my experience this was not so.

Maisie Levinge's recent article (1954) is of interest. She considers (1) that orthoptic treatment is valueless in overcoming abnormal retinal correspondence, (2) that the patient is more fortunate in having the positive advantage of anomalous correspondence than in experiencing the negative condition of complete suppression, and (3) that abnormal correspondence can be used as a basis for treatment and actually has become beneficial to adult patients with poor binocular convergence. If, then, we fail to remove abnormal correspondence, we may enable the patient to make use of it.

What is the benefit of early operation? (table IV and V)

Nordlöw, 1951, found that of 22 children operated on early, 91 per cent developed binocular vision.

Fortunately the age of the patient is not so vital when treating abnormal correspondence as it is in the treatment of amblyopia. The return of a normal relationship is not uncommon when surgical intervention is undertaken in the second decade of the patient's life, and has been known to occur when it has been deferred until the fourth decade.

TABLE IV

INFLUENCE OF AGE OF CHILD AT OPERATION IN NONACCOMMODATIVE AND PARTIALLY ACCOMMODATIVE CASES, WITH ONSET BEFORE THE CHILD IS THREE YEARS OLD

AGE AT OPERATION YEARS	NUMBER OF CASES	NC AND/OR EYES STRAIGHT TO COVER TEST	
		NUMBER	PERCENTAGE
Under 3	10	7	70
Between 3 and 5	32	17	53
Between 5 and 10	53	19	38
10 and over 10	11	3	27

INFLUENCE OF VERTICAL DEVIATION ON SURGERY

The incidence of vertical deviations, as revealed by the cover test in oblique directions and by the synoptophore measurements, varies with the type of strabismus, as already shown. Correction of horizontal errors is more difficult if vertical errors are present. If such errors cause diplopia, it is more annoying when variable, when in the lower field, or when associated with tilting of the images. It is of interest that vertical deviations figure so little in Kein-

TABLE V

THE OUTLOOK FOR CONVERTING ABNORMAL TO NORMAL CORRESPONDENCE

ONSET	NUMBER OF CASES	NC PERCENTAGE	TOTAL ARC CASES	ARC TO NC PERCENTAGE		RETAINED ARC PERCENTAGE
				BEFORE OPERATION	AFTER OPERATION	
Under 6 months	61	7	57	9	30	61
6 months—1 year	51	18	42	10	39	52
Over 1 year—2	61	43	35	29	37	34
Over 2 years—4	61	61	24	38	29	33
Over 4 years	19	79	4	0	25	75†

*Adapted from Table VIII in "Cross section of cross-eyes" (Anderson, 1931).
†This group is too small to be significant.

er's recent report. One wonders if further use of the red and green projection test and the cover tests would have revealed more of them.

The frequency of alternating hyperphoria (or sursumduction) with its possible dependence on unbalanced optomotor reflexes calls for caution in surgery. As already stated, when binocular vision is still immature, Hering's law of binocular innervation need not apply, and the primitive monocular optomotor movements may be seen. A relatively weak influence of the inferior nasal quadrant of the retina on ocular motility, according to Crone, causes characteristic deviations of the occluded eye, viz., sursumduction, excycloduction, and abduction.

> These movements have a coordinated character and have nothing in common with the isolated relaxation or contraction of one or several eye muscles. The direction of gaze has no influence on the trend of the movements, and especially the rotatory component does not increase at the expense of the vertical component when the covered eye is abducted.

A similar influence acting at a supranuclear level may account for certain cases of oblique strabismus. So far I have failed to observe a patient of over 35 years with alternating hyperphoria.

One characteristic of such vertical defects is their ability to change after operation for horizontal deviations, or simply with the passage of time. This explains why a previously apparent underaction of the superior oblique muscle may be absent after operation, and why an alternating hyperphoria may not be found at the beginning of treatment.

Most surgeons agree that not infrequently the results of a simple operation for strabismus are unexpected. This may be evidence of an underlying imponderable innervational factor. Further evidence of this comes from the varying influence of the correction of a given refractive error and the influence of the emotional state of the patient on certain deviations.

O'Brien, 1950, found that a given operation could produce from 5 to 20 degrees correction in eyes with similar deviations. The size of the eyeball may have been a factor. Allowance was apparently not made for either age or the refraction of the patients. Even in emmetropia the axial length is inconstant. Results may be even more uncertain when a vertical component is present. All these points suggest an interference at a supranuclear level rather than at a lower level.

A warning is necessary against premature interference with vertical muscles lest correction of horizontal deviations make such unnecessary. The neuromuscular consequences of altering ocular balance by operation may be important. "The secondary effect of the changed anatomical condition on the neuromuscular adjustment and even on the tonus" must be respected (Lancaster, 1950). Lancaster in his wisdom frequently reminded his readers of the supreme importance of the neural factor. The up-shooting adducted eye, for example, "is not a universal thing. It occurs only when the neural mechanism works that way. It may appear after occlusion for some weeks and recover without operative treatment" (Swan, Lancaster, 1950).

To a certain extent we agree with Swan (1950), who considers "that most oblique surgery in nonparalytic esotropia is not justified, because the 'overaction' is usually functional in origin and gradually disappears when the eye is not maintained in the adducted position." He advocates alternate occlusion to prevent the development of, or even to correct, this "overaction" which is prone to develop in an eye which is persistently adducted. Forcing such an eye to fix may remove this tendency. The encroachment of the nose on the inferior-nasal field, which rapidly increases in adduction, may represent a form of cover test. If, however, a remnant of a superior muscle paresis persists, a myectomy of the inferior oblique muscle will be necessary. As the results of the myectomy of the inferior oblique muscle are variable, it is sometimes wise to perform it first, when it is indicated, as one of a series of operations to correct a large angle. On the other hand the neuromuscular mechanism may correct a horizontal deficiency after an operation for vertical errors.

Scobee, 1950, considered eighteen factors that might affect the results. For only some of these can allowance be made. He found that regardless of the degree of hyperphoria, from 10 to 25 diopters, recession of the superior rectus to the equator may be satisfactory.

Need we consider the apparent strength of the exposed muscle when so much of its power is held in reserve? "One cannot judge from the size of the muscle how many of its fibers are being innervated" (Lancaster). It is the fusion mechanism, once given a chance, that effects the cure —provided we have operated on the right muscle.

Scobee found that while a few patients without a vertical component gained fusion, only half as many did so if one was present. The probable preponderance of accommodative cases, some being intermittent, would influence this finding. The separation of such cases is as vital when considering treatment as when analyzing statistics.

Good fusion acquired before operation, even in the absence of normal correspondence, may aid the results of operation.

How then can we determine which vertical errors to correct when the horizontal error is not small and the vertical disorder is not typical of a paretic syndrome? I prefer to correct the horizontal error and watch.

Variations with oblique gaze and head tilting are of the greatest significance and often justify a combined operation.

Scobee found his method of estimating mechanical defects a valuable guide, but

he never operated on vertical and horizontal deviations at once.

White and Brown, 1939, finding the functional cure of this combined form of squint rare, advised the treatment of the vertical imbalance first. Costenbader, 1950, agreed with their estimate of vertical errors as obstacles when correcting horizontal deviations but doubted whether obtaining vertical alignment first had much influence on the final result. Fink, 1952, has been successful in treating combined deviations with prism neutralization of the vertical error. If this fails to correct the horizontal deviation, he operates on it first. Apart from this, my observations support his principles:

1. In general a vertical deviation of more than 15 prism diopters is best corrected at a primary operation or a combined one.
2. If the vertical error is greater in amount than the horizontal error, it should be operated on first.
3. When the horizontal deviation is sufficiently great to prevent study of a vertical error, it requires operation first.
4. If the vertical error is slight or the apparent overaction of an oblique muscle not marked, it is wise to correct the horizontal defect first.
5. A recession of an internal rectus that would be correct in the absence of a vertical defect may occasionally undercorrect, but more commonly overcorrect, the horizontal deviation.

Because of the presence of hypertropia and because of the variable results from surgery, several operations may be necessary. It is certainly easier to arrange these now that anesthetics are less dreaded and the convalescence so much simpler. After nembutal or seconal, the child should come to the anesthetic room asleep. If not, pentothal soon produces sleep, and amnesia is complete. Vomiting is very rare. After a recession, a pad is used for one day, and the child is then allowed to go home. Luminal, albucid, and sometimes an antibiotic are used. If a resection has been performed, the pad is retained longer but the child goes home. If both eyes are operated on, both eyes are usually open and the child is at home within three or four days. Bandages are never used, and only sutures that need not be removed are employed. The fear of an operation no longer exists, and with it has gone the deleterious effects on the nervous system that used to worry a thoughtful physician.

UNSATISFACTORY RESULTS

In "Cross section of cross-eyes" (1951), I took as evidence of cure an angle less than 5 degrees, a fusion range of 10 degrees, and stereoscopic vision. I was disappointed with the following results:

1. Normal Correspondence without operation—only 47 per cent were "cures"
2. Normal Correspondence with operation—only 31 per cent were "cures"
3. AC = NC before operation — only 16 per cent were "cures"
4. AC = NC after operation — only 4.5 per cent were "cures"

Why were the results so bad? In the first two categories, some of the failures were probably due to glasses that were too weak or astigmatism that had been inadequately corrected, and others to insufficient occlusion.

Burian wrote, "A stable normal correspondence evident in all tests is only rarely achieved by operation alone." This is because there is usually a small residual angle, and because normal control by fusion is absent. Normal may replace abnormal correspondence spontaneously after accurate operation in cases of squint that were of late onset and that had been intermittent. (See Lyle, 1953, p. 102.)

CERTAIN PROBLEMS

1. The delay between onset of strabismus and the first visit to the oculist. As Julia Lancaster emphasizes, the ideal time to train a child to use binocular vision is during the period of life in which it normally develops.

2. The intellectual immaturity of the patient during this period.

3. Lack of parental interest.

4. Inaccuracy in assessing the deviation in terms of the patient's future well-being. Treatment should not be a greater handicap than the deviation.

5. Expecting orthoptics to alter structural defects or to produce fusion when the ability to fuse is absent.

6. Difficulty in knowing what a child sees and means.

7. Difficulty in knowing what other oculists and orthoptists mean, owing to lack of standardization in terminology and technique.

8. The application of findings of instrumental tests to everyday seeing.

9. A tendency to draw conclusions from a small or inappropriate series.

10. The making of loose statements and misquotation of others, e.g., Travers has been wrongly quoted as saying ARC never occurs "if angle is less than 10 degrees and rarely if less than 20 degrees." Chavasse has been misquoted as saying that an amblyopic eye can be expected to recover only that vision which it had when the squint started: actually he was referring only to recovery of vision in later life.

11. We may attribute squint to "abnormal projection" or vice versa, while both are signs of the failure of the normal reflex movements of the eyes (Chavasse, Diana Mann, Keiner).

12. A mechanistic viewpoint that permits the division by hard and fast lines of processes that are plastic and transient.

13. Our ignorance of the reason why so many children with predisposing factors do not squint.

Having inadvertently demonstrated at least some of these errors in this paper, I will close. But first let me express my gratitude to you for your patience, and to the orthoptists—Diana Mann, Beverly Balfour, June Burns-Priddle and Merilyn Jacobs—to whom my patients and I owe so much.

The greatest gains in our treatment of squint in the last twenty-five years have come from the orthoptists, and our gains will be greater in the next twenty-five if we will listen to what the orthoptists and the physiologists say.

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Symposium: Surgery and Orthoptics

THE INVESTIGATION AND TREATMENT OF THOSE CASES OF STRABISMUS AND HETEROPHORIA FOR WHICH SURGERY IS CONTEMPLATED

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IT is my wish to give as comprehensive a view as possible of the current British view on the subject chosen for discussion. It is proposed to lay particular emphasis on the investigation and preoperative treatment of those cases in which surgery is contemplated.

In the treatment of strabismus, the orthoptist's role is considered to be twofold —diagnostic and therapeutic.

First, it is necessary to diagnose the type of deviation and, when applicable, the extraocular muscle palsy or overaction involved; then an assessment must be made of the grade of binocular vision present and the degree to which binocular function has become disturbed by the onset of a squint. Finally, a prognosis has to be given.

The therapeutic intention is to prevent abnormal sensory adaptation to the changed ocular posture and to re-establish normal sensory function if this has already been altered by the motor abnormality.

Before discussing the clinical aspects of surgery and orthoptics in detail, it may assist understanding of the British approach to the subject if a brief account is given of the conditions under which orthoptists practice in the United Kingdom.

An orthoptist holding the Diploma of the British Orthoptic Board works only under the direction of an ophthalmic surgeon. According to the current National Register of Medical Auxiliary Services, every orthoptist in the United Kingdom is employed, at least part-time, within the framework of the National Health Service, either in hospital departments or in clinics administered by county or city educational authorities.

All patients entering hospitals are referred in the first instance by their family doctor. In the out-patients' department a history is taken and refraction and examination of the fundi and media are carried out. In the case of children, refraction is performed under full cycloplegia and the patient attends the orthoptic department for the first time when glasses, if ordered, have been dispensed. Adults, on the other hand, are frequently referred after refraction but before glasses are ordered, and the final prescription is governed by the orthoptic findings. Under the ethical rules of the British Orthoptic Board, an orthoptist is not permitted to prescribe spectacles, and she is not required to perform refractions, although her advice is often asked on the correction to be prescribed.

At the patient's first visit to the orthoptic department, a detailed history is taken and recorded on the orthoptic case sheet, which is kept readily available throughout the course of treatment. During the first interview the orthoptist learns much of the personality, general health, and home background of the patient, and the

Read at the Joint Meeting of the American Orthoptic Council and the American Association of Orthoptic Technicians, September 19, 1954, New York, N. Y.

relevant facts are given in the orthoptic report when the case is presented to the surgeon.

The prognosis as regards binocular function is also included in the first report, and this may be reviewed from time to time as treatment proceeds. Frequently the surgeon may ask advice on the optical or surgical treatment, but it is always the orthoptist's duty to advise on the indication for orthoptic treatment.

Evidence of the increasing use of the orthoptic department for diagnosis and advice in cases in which orthoptic treatment is *not* indicated, is provided by an analysis of patients attending two orthoptic departments in London during the year ending March 1954. This analysis shows that orthoptic treatment was not indicated in over 39 percent of the total number of patients referred to the departments, compared with 31 percent in 1950.

Included in the analysis were patients complaining of diplopia. They were referred for diagnosis of the affected muscles, for determination of the state of binocular function, and for the differential diagnosis of congenital and acquired palsy or of recent and long-standing paralytic conditions. The orthoptic report thus formed a basis for general investigations, where indicated, or supplied confirmation of the congenital nature of the defect, making such investigations unnecessary. Another large group of patients was referred for advice on the possible risk of diplopia after cosmetic operation.

Four years ago, in 1951, Dr. Walter B. Lancaster,[6] writing in the first ophthalmic symposium on strabismus, made a plea for "better cooperation between surgeon and orthoptic technician, so that the technician without embarrassment might take up the question of preliminary operative treatment or (which is most likely and more embarrassing) the question of further operation to secure a nearer approach to the surgical goal, when the surgery has been inadequate."

At the present time it may be said that, generally speaking, this cooperation is firmly established in Great Britain. At the initial consultation between patient, surgeon, and orthoptist, an explanation of the condition is given to the patient and the probable course of treatment and the end-result are discussed. Similar discussions take place as each stage of treatment is reached or, if the orthoptist requires the surgeon's advice, in the course of treatment.

Ideally, the patient should be seen as soon after the onset of squint as possible, so that the appropriate refractive, orthoptic, and surgical treatment may be carried out without delay, and normal binocular function established or restored at the earliest opportunity.

In those cases of convergent squint in which the sensory pattern has not yet been disturbed sufficiently for secondary changes to have taken place, orthoptic treatment aims at ensuring that equal visual acuity is maintained, and occlusion is carried out, when necessary, in cases of unilateral squint.

If the patient is old enough, antisuppression exercises can be given to overcome or prevent suppression. Fusion and stereoscopic vision should be established preoperatively whenever possible. Some authorities advocate home exercises and encourage alternation and the recognition of diplopia by means of red and green glasses. Diplopia is, however, often recognized spontaneously if the patient's attention is drawn to it, and it may then form the basis for clinical and home exercises designed to facilitate the recovery of binocular single vision in all circumstances.

It is often found that a child of from 2½ years old can safely be left without occlusion when he can maintain fixation easily with either eye and shows some ability to fuse the pictures on a major amblyoscope at his correct angle of deviation. He should, however, be seen at regular intervals of not longer than three

months, and occlusion can be resorted to if either amblyopia or abnormal retinal correspondence shows signs of developing.

By leaving the patient with both eyes open, the desire for binocular vision is not prevented, and, as in many patients the deviation may be intermittent, there is a chance that binocular vision may occur at times.

In those cases in which surgical treatment is necessary, the operation aims at making the visual axes as nearly parallel as possible, or a few degrees convergent.

There is a general trend in Great Britain to operate on very young children, even at the age of only one year. Surgery is undertaken as soon after the onset of the squint as possible, in the hope that normal development of the binocular reflexes may be resumed. Early surgery has been facilitated in some hospitals by the practice of leaving the eyes unpadded after operation.

An exact preoperative diagnosis is an essential factor in a successful postoperative result. The younger the patient, the smaller is the amount of surgical interference required to overcome the deviation.

In the type of accommodative squint in which binocular single vision is present for distance but gross overconvergence takes place for near, it is the practice for an ophthalmologist to prescribe a correction of the manifest hypermetropia. Some authorities consider that the deviation for near disappears with time, when the convergence reflex becomes less exuberant. In any event, the patient can frequently be taught to control the deviation at reading distance with little difficulty, though the binocular visual acuity is found to be poor. If this fails to improve after exercises to dissociate accommodation and convergence have been given in conjunction with clip-on lenses of decreasing strength, additional treatment is indicated. Whether this should take the form of bifocal lenses, an additional correction for close work, or operation is, however, a matter of opinion.

It is generally maintained that patients with divergent strabismus require operation, even if the squint is of the intermittent type. Surgical treatment also appears justified in cases of divergence excess, although a perfect functional result is not always obtained postoperatively, but the patient's symptoms are frequently relieved by enabling him to maintain binocular single vision more comfortably. The usual policy is to delay surgical treatment in cases of divergent strabismus until the patient is at least 9 years old.

When a vertical deviation exists, a most careful diagnosis must be made in order to achieve a good postoperative result. It may be difficult to assess accurately those cases in which a vertical and a horizontal deviation co-exist, especially if the patient is very young or is not cooperative.

The Hess screen is invaluable in such cases, and recent adaptations of this instrument have simplified its application by eliminating some of the original disadvantages. The Lees screen, for example, by reason of its uncomplicated design, which incorporates a tangent scale devised to give a high degree of simultaneous contrast, may be used accurately even for a four-year-old child.

In some cases of primary vertical deviation, either of congenital origin or of early onset, binocular single vision is developed and maintained by means of a compensatory head posture, giving rise to ocular torticollis. Here we have a condition in which the field of binocular fixation is limited in area though not in quality. There is no immediate secondary convergence or divergence and the sensory pattern is not violated by binocular anomalies.

Two points of diagnostic importance in the preoperative examination of such cases are worthy of special mention.

1. It is useful for the surgeon to know with which eye the patient prefers to fix on dissociation. It is the fixing eye which determines the innervation of the nonfixing

eye, and it is the deviation of the nonfixing eye which needs to be corrected. It is, therefore, important to perform the cover test for near and distance in those directions in which a vertical deviation is manifest on both elevation and depression, and to note any preference for fixation which will be of assistance when surgical treatment is planned.

2. The vertical fusion range is greater in these cases of congenital origin or of early onset because the binocular reflexes have been developed in the face of a latent vertical deviation. Many patients find a vertical fusion break during convergence and divergence on a major amblyoscope, that is to say, the vertical defect influences the horizontal fusion range. After examination with different vertical adjustments, a comfortable fusion range is discovered, and the hypertropic reading at this stage may be considerably less than the objective hypertropia assessed by flashing. This information may prove helpful to the surgeon in considering the extent of surgical treatment, since many patients experience great discomfort if their maximum objective hypertropia is corrected.

In those cases in which the sensory pattern has already become abnormal in an adaptation to the existing motor anomaly, orthoptic treatment must first be directed to the elimination of amblyopia ex anopsia, if present. Visual acuity is not easy to estimate in a child under three years old but he can be treated for amblyopia if he finds it impossible to maintain fixation with the deviating eye when the cover has been removed from the fixing eye.

It is the general practice among British orthoptists to use total occlusion when the visual acuity is 6/18 (20/70) or less. If there is any improvement, occlusion is continued until it is found either that there is no further improvement or that the visual acuity has become equal. The average rate of improvement with constant total occlusion is one line on Snellen's test chart each month. This may be more rapid in patients under 6 years of age, and it is advisable to see all patients at least once a month.

No special amblyopia clinics are known to exist in Britain, but reliance is placed on various methods of monocular stimulation which can be carried out at home.

It is generally agreed among British orthoptists that age is no barrier to the improvement of visual acuity in cases of amblyopia ex anopsia. It is, however, better to treat the patient with this condition as early as possible, first, because the results are more rapid and, second, because to wear an occluder is less disturbing for a young child than for a child of school age.

It has been found that in children 10 years old and older an occluder worn at home for reading, watching television, and so on, may have good results if properly used, but this method is necessarily slow. In the treatment of amblyopia, as in every phase of orthoptic treatment, it is essential to have the cooperation of the patient and his parents, and it is well worth the trouble to review each case individually, prescribing treatment according to the patient's requirements, habits and way of life.

Amblyopia may prove intractable in any age group, and it is not easy to make a prognosis until constant occlusion has been carried out for at least three months. Some recent work undertaken by Parsons-Smith[8] (1953) and others in connection with electroencephalography may throw some light on the etiology and prognosis of these baffling cases.

Some orthoptists prescribe alternate occlusion for patients with abnormal, or lack of normal, retinal correspondence until operation is performed, in the hope that the abnormal sensory pattern may be eliminated. It is generally considered best to operate as soon as the visual acuity is equal. If amblyopia is intractable, surgery is planned to leave the patient with up to

10 degrees of residual convergence, allowing for physiological divergence to take place with the passage of time.

Where there is abnormal retinal correspondence, it is advisable to plan the surgical result so that the visual axes can be made as nearly parallel as possible. When this is done, there is no incentive for the patient to resort to his former angle of deviation. If he is left with a convergent deviation of 15 degrees or more, he may in time resume his former angle of deviation in order to regain his habit of fusing with noncorresponding retinal points.

However, Levinge[7] (1954) has shown that in cases where abnormal retinal correspondence exists in spite of adjusting the visual axes, the sensory pattern after operation has been of value in producing a type of binocular vision. In fact, it appears that, if encouraged, persistent abnormal retinal correspondence can maintain a satisfactory result instead of giving a poor surgical prognosis with reversion to the original deviation.

It is generally agreed that established abnormal retinal correspondence never responds to orthoptic treatment, and treatment is only given as a diagnostic measure when the state of binocular correspondence is open to doubt at the first examination.

It is interesting to note that very few cases of abnormal retinal correspondence are found now that patients are referred to orthoptic clinics so much earlier. It is also true that the incidence is appreciably higher in districts where the squinting child is only given glasses, when indicated, and is left without further treatment until school age.

As the binocular reflexes are acknowledged to be in a state of flux for the first eight years of life, a reversion to more primitive automatic behavior patterns is possible under emotional stress.

In a recent paper read at the 1954 Conference of the British Orthoptic Society, which is to be published in the next issue of the British Orthoptic Journal, Doctor and Mrs. Bobath[1] describe the treatment of cerebral palsy by their method of reflex inhibition and facilitation of movement. They state that in an emergency and under emotional stress we revert to our original postural and movement patterns. Underlying these behavior patterns are very primitive automatic patterns, such as flexion of the body, clenching the teeth, and closing the hand in a state of stubborn determination.

The Bobaths find a loss of adequate inhibitory control in all cases of cerebral palsy. There is a lower threshold of excitability and, therefore, widespread response to local stimuli such as light, emotions and noise. The response occurs whether the stimulus is great or small. In every central nervous system there is a point up to which inhibition is maintained; after this critical point it is lost, but before it is reached there will be normality of muscle tone and movement.

In a young child in whom the refinement of inhibitory control has not been fully developed, we find a common demonstration of this in the exuberance of the convergence reflex as described by Chavasse[3] (1950). This might be relevant to the observation that the history of the onset of squint is often associated with some emotional factor.

The emotional factor has been stressed again by Parsons-Smith[8] (1953) in recording the electroencephalographic investigations in a series of 50 cases of strabismus referred from the orthoptic department at the Western Ophthalmic Hospital, London. He finds that 62 percent of his subjects showed grossly abnormal electroencephalograms; in 14 percent the records were borderline; and in only 24 percent were they considered to be within normal limits for the age groups. Another surprising finding was the high incidence, 16 percent, of epileptic dysrhythmias seen over the cortex of children in whom there was apparently no previous history sug-

gestive of epilepsy, though in the majority such a history was obtained when the parents were taxed in the light of the findings.

These results were said to support those obtained by Stillerman, Gibbs, and Perlstein (1952), who reported that 20 percent of children examined with strabismus had brain changes, while only 0.5 percent of those without strabismus demonstrated abnormalities of this type.

Parsons-Smith in the same paper advocates anticonvulsants and sedatives for patients with abnormal electroencephalographic readings when they are admitted to the hospital.

Fifty years ago Duane[4] (1896) remarked, "We should always feel that a diagnosis is provisional, and that a really satisfactory diagnosis should express the cause of the deviation as well as its character." Today there are still many factors in the etiology of the condition which remain obscure, both as regards the onset and the various ways in which the sensory pattern is adapted in the face of an existing deviation.

Worth[9] (1903) first drew attention to the developmental aspect of squint, and advances in physiology made it possible for Chavasse to postulate a more exact concept of the binocular reflexes, this led to a greater emphasis on the general and mental development of the patient when the cause of a squint was being considered.

It is clear that further advances are unlikely without the coordination of research in many fields. The orthoptist, with her special opportunities in her own sphere for observing a patient's reactions in various circumstances, is responsible for providing much of the clinical data necessary for research. Within the past few years, for example, there has been increasing interest in small-degree esotropia with fixation disparity (Gittoes-Davies and others,[5] 1951, 1952, 1953), and this has recently culminated in a survey by Cashell[2] (1954).

It is, however, important that a constant interchange of views and orthoptic findings should take place on an international basis, and the American Orthoptic Council and the Association of American Orthoptic Technicians are to be congratulated on providing, in this meeting, an excellent example of how such an exchange of views can take place.

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SOME TECHNIQUES FOR DEVELOPING RELIABLE RESPONSES

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THE sensory and motor aspects of fusion are inseparable in the individual, but years of experience in measuring deviations have developed our skills in this area far beyond our facility in evaluating the sensory components of the fusion act.

Sensory fusion is subjective. By definition it is the portion of the fusion act which takes place in the brain; it is what the patient does with the images he receives. He may do four things: fuse, recognize diplopia, establish anomalous correspondence, or suppress, and these various interpretations may be constant or intermittent, or may exist in a combination of patterns.

Our first duty as technicians is to discover the sensory status of the patient, and then to correct faulty adaptations and develop fusion habits as normal and stable as the motor status of the patient permits. In the presence of motor obstacles, such as paresis, normal sensory fusion is not possible. When adjustment is made to the motor problem, as on the major amblyoscope, by the introduction of surgery, or even by correction of refractive errors with glasses, so that the patient *does* receive fusable images on corresponding areas, sensory fusion does *not* necessarily take place; the patient may continue to use the sensory adaptation he has already made, or develop a fresh one that is still not normal.

It is the province of orthoptic technicians to investigate the moment-to-moment perceptions of the patient and interpret them in terms which will help us establish situations in which the perceptions will more closely approximate normal.

Only the patient can give us information about *how* he sees. He can do this in three ways: by what he says, by what he does, and by his emotional response as shown in his facial expression and general behavior. The chief difficulty in collecting this evidence arises from the ignorance and lack of experience of the patient in recognizing his binocular sensory status. He sees, but the way in which he responds to visual stimuli may or may not be an accurate indication of what he sees. A common example of this inaccuracy is the response of a patient trying to describe diplopia. He says he sees "two." Does this mean he has diplopia, or does it mean that he sees first an image with one eye and then one with the other eye, but lacks the vocabulary and experience to describe this alternation? The patient moves the handle of the amblyoscope and says the targets "fit." Is the lion then in the cage, or is he only part way in but far enough to suit the patient, or has he disappeared and discouraged the patient so that he decides to use a satisfactory word to substitute for a satisfactory perception? What the patient says or does is not proof of his sensory status. He must also give evidence that he knows how to convey his perceptions, is competent to make observations of the fusion situations, and is honest in his efforts.

There are two main sensory problems to be analyzed. First, is the patient accepting images with both eyes or is he suppressing one of them, in whole or in part? Second, if he is not suppressing, has he correct perception of the relationship between the two images—localization in

From the Sacramento Orthoptic Laboratory.
Read at the Thirteenth Annual Meeting of the American Association of Orthoptic Technicians, September 20, 1954, New York, N. Y.

space? The subsidiary problem in each case is to determine whether his errors are due to a true sensory adaptation, such as anomalous correspondence, or merely to inexperience and inaccuracy in describing his perceptions, or to such disinterest and dishonesty that he is making no effort to relate his responses to the facts of the situation.

The primary technique for finding out whether the patient is accepting images from both eyes is to ensure that he receives a stable foveal image from *one* eye while the second eye is so stimulated as to permit an image sufficiently related in character to be interpreted by the brain as either simultaneous perception or fusion. Interpretation can be quick, but in the young child the transmission of such interpretation to the technician by word or deed is time consuming. It is not enough for the patient to get an instantaneous stimulation; he must have time to understand and report on it. Hence stable fixation, at least half a minute, is essential for reliable study of the sensory status.

During the time that the patient is receiving images he must make three separate interpretations and report on them to the technician. First he must count them, one or two. Second, he must inspect them for their character: what color, if he is using a red filter, or are both check-marks present if he is working on an amblyoscope or stereoscope. Third, he must evaluate the relationship of the images in space: are they disparate; if so, how far apart and on which side, or are they fitted into one. Each of these observations gives a clue to each of the four possible sensory adjustments: fusion, diplopia, anomalous correspondence, and supression.

Techniques for establishing fixation stable enough to permit these various observations require that the patient look at the target and *prove that he is looking* by describing something about it. Collecting proof of fixation, and hence of sensory perception, is the difference between measurements of motor status and stimulation at the mechanical level of the stimulus-response mechanism, and the study of the complete visual act. It is the difference between the kind of diagnosis based on the corneal reflexes and a complete orthoptic study of the patient's sensory status. Reliable responses bridge the gap between motor stimulus and sensory evidence; they answer the question, "In the presence of this stimulus (such as central corneal reflexes) what does the patient perceive?" Sensory fusion cannot be studied by objective methods alone, and the patient's answers to questions about how he sees are not proof of his sensory status unless his *ability* and *reliability* in making observations have been demonstrated in appropriate ways. The two principal criteria in checking his answers are consistency in reporting identical situations and promptness in reporting change. Consistency is very boring to the child, and careful differentiation must be made between actual failure to observe and mere change of wording due to disinterest. For this reason I am very strict about the wording acceptable in a given situation. I feel, for example, that if three different wordings are acceptable and a fourth one is criticized, the patient can only be bewildered by having some inconsistencies accepted and not others. I permit *no* inconsistencies (change) and find patients soon settle down to accepting my words and abandon their imaginative descriptions of the situation.

A second aspect of this technique for reporting on a target is the selection of suitable fixation material. It must have detail suitable for quick, accurate description. I avoid lights for fixation: there is so little to say about them! I find patients who have been conditioned to say "I see the light" when they are not fixing on it at all. Some of them are reported to have eccentric fixation, but when asked to "see if the kitty has a bow on her neck," they manifest foveal fixation very well. In the absence

of stable fixation, the patient cannot collect the necessary evidence. In the presence of stable fixation, is he reporting reliably on his perceptions?

The first check must be made on his skill in distinguishing between one and two. Many errors in orthoptic diagnosis are made because there has been no adequate study of the patient's use of the words, especially the word "two." Two may mean for him either simultaneous or consecutive. The one indicates diplopia; the other, alternation. There are three convenient ways to check this.

The first check is to remove the possibility of a second image (barring monocular diplopia) and note whether the patient recognizes the loss: extinguish one light on the amblyoscope, or deftly cover one eye.

A second check is to change the fixation target, replacing one to which the patient has a conditioned response, "ought to be two," for a new and more casual object. Thus a patient who says the office toy-on-a-stick is two, admits that a pencil is one.

The third check is made by placing a red filter over one eye and discussing which color is missing—red—or white. If this is done with a cover over each eye in turn, the patient will often admit subsequently that one color is still missing when both eyes are exposed. It is important to condition the patient to making a negative report. Thus, if the eye with the red filter is covered, the patient should sometimes be asked, "Is red the right answer?" Of course it cannot be. This prepares the patient to say "No" when both eyes are exposed and he is unable to fix with both eyes. It is especially useful when the patient may or may not be fusing "pink," and the correct observation of "No, it is not pink" is invaluable to the technician.

By creating a situation is which alternation is slow and dramatic, the technician can make the opportunity for diplopia a striking contrast which will make it easier for the patient to notice if it is present at all.

For the most immature patient, a demonstration of the difference between one pencil and two pencils, or one finger and two fingers, is often necessary.

If the patient sees one object consistently, the next check must be on the character of the single image: is it fused, or is the secondary image suppressed? It must always be borne in mind that in casual seeing there are no clues indicating whether a single image is monocular or binocular (unless there is a marked difference in visual acuity or uncorrected anisometropia or a very adult perception of loss of visual field in monocular fixation). To the average patient, one with the right eye, one with the left eye, and one with both eyes are all alike. Hence, a large part of orthoptic training consists in controlling the images so that there *is* a difference. When coaching a patient in making accurate reports on what he sees, the differences should be dramatic and of a character to make them valuable to the technician. Control can be most accurate on the amblyoscope, where size, brightness, color, and location of check marks have unlimited variation. The red filter serves a similar purpose off the amblyoscope. So, for more advanced patients, does the use of physiological diplopia by means of various bar-checks. The important technique is to keep the patient's attention at all times on what is "lost" or missing. This places the psychological emphasis on the *lack* of binocular perception, on the errors of binocular vision. The patient should not be permitted to report on the recovery of suppressed areas without a report on the status of the "other target," i.e., not "I found the red" without a report of "I lost (or still have) the green." Patients who report that they see "something" are not giving an adequate orthoptic report on their sensory status. Any patient who is not amblyopic is "see-

ing." Our problem is to determine how he is seeing. Single vision is only one clue to sensory status. The character (fused or suppressed) of the image must be interpreted.

If the patient sees two, he must learn to report the location of the second image. This calls for reasonably mature perception of spatial relationships, and children often lack the vocabulary, as well as the experience, to report this accurately. Not only are right and left confused, but "far apart" and "close together" are confused with "far away from me" and "close to me." Units of measure, such as inches, are not understood. It is useful to relate direction to something in the room, such as "door side," or "window side," and distance to "room for one in between."

Most important of all is the patient's reliability in reporting *loss* of the second image. The psychological implication of failure when something is lost is very difficult for patients to tolerate, but this is of extreme value in impressing them with the importance of maintaining fixation with both eyes.

Since the object of diplopia practice is to encourage fusion of the two images, extreme care must be taken by the technician to be sure that change from two to one is associated with fusion and not suppression. For this reason it is helpful to encourage "touch" and "overlap" for long periods of practice before perfect fusion is finally encouraged. Claims of fusion off the amblyoscope must be checked by red filter or physiological diplopia before they are acceptable.

These techniques cover the possible adjustments of fusion (the perfect image), suppression (the imperfect image), and diplopia. There is left, anomalous correspondence. This is simply a compound study of suppression and diplopia, with anomalous fusion. The patient still needs stable fixation to give him time to make observations, and coaching in how to report spatial relationships with accuracy and honesty about changing situations. The findings will be different, but the techniques for collecting evidence are basically the same.

To develop reliable responses about sensory status, the patient must have time to collect evidence by maintaining stable fixation. He must be presented with dramatic material, easy for him to evaluate. He must be taught how to express his perceptions by words or gestures. His statements must be checked by changing the situations so that new statements are necessary if he is to give a true report on the facts as he sees them.

If statements contrary to facts are permitted from a patient, then treatment contrary to what is necessary for him is the inevitable result. We are all alert to the error of stimulating anomalous correspondence. We must become equally alert to the fallacy of expecting fusion in the presence of monocular perception only, or vergence control in the absence of two images. To avoid fallacies in treatment, we must seek for reliable evidence of sensory status. Only the patient can give us this, and only careful coaching can develop his responses so that his information is prompt and accurate.

REMARKS ON ORTHOPTIC TRAINING

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IT is a great honor and a pleasure for me to have the opportunity of telling you something about the results of my researches in the treatment of strabismus.

To begin with, I should like to give you a brief historical survey.

As far back as the nineteenth century, physiologists and oculists on the European continent were highly interested in the problems of strabismus, and it stands to reason that from their interest there issued an effort to treat this defect. Javal may be regarded as the father of orthoptic training. Now there is the striking fact that the torch lighted by Javal was not passed from one country to the other on the Continent but was handed over to England and to your country, where orthoptic training became greatly developed. The interest on the Continent continued to be mainly theoretical, and even now a great many ophthalmologists occupy themselves only with the physiological aspects of muscular imbalance (e.g., C. Otto Roelofs), whereas only a small number utilize orthoptic training. It is not easy to detect the causes of this development on the European continent; there has always been very great skepticism regarding orthoptic treatment.

Before World War II, well organized and liberally managed orthoptic training was found nowhere on the European continent. After the war, by renewed contacts with the English-speaking countries, this method was developed here and there in the different countries, so that nowadays at some places in Belgium, France, Switzerland, Germany and Holland the orthoptic training which is practiced is really justified. There is not yet organized and regulated training of orthoptic technicians and we depend mainly on England for education in orthoptics.

Apart from this development, an entirely new method of treating amblyopia has been developed in Switzerland under the guidance of Bangerter. Those interested in this method can find it in his monograph, which describes minutely his ingenius methods and their results.

In my opinion, English and Swiss influences are at present coming together on the European continent, and this combination is developing a method guaranteeing success. The presence of so many skeptics on the Continent, on the one hand, prevents us from prematurely striking our breasts and, on the other hand, increases the possibility of control and direction falling into the hands of the orthoptist.

In all modesty, I present our orthoptic department as a specimen of the confluence mentioned above. My technician, Miss Weil, has repeatedly visited orthoptic centers in England as well as in Switzerland, and I feel extremely happy that now I can put such satisfying results before you, owing in a great measure to her application, staying power and pedagogic qualities.

But the analysis of the cases of squint in my own practice has also produced a number of interesting facts. I do not like to trouble you too long with boring tables, and that is why I am now presenting these experiences in a short survey.

Read at the Thirteenth Annual Meeting of the American Association of Orthoptic Technicians, September 20, 1954, New York, N. Y.

Our experience with convergent strabismus amounts to a little more than 500 cases. In these cases, the number of females appears to be significantly higher than the number of males. When you realize that our Dutch population under the age of fifteen consists of more boys than girls, it will be clear to you that in our country disfigurement by strabismus occurs more often in females than in males. Waardenburg has already drawn our attention to this fact. The right eye squints nearly as often as the left one; the difference is not significant. Many squinters (about 50 per cent) report that squint also occurs among their relatives. However, as long as we don't know precisely the composition of the family, these data cannot exactly be assimilated, for not only must we use a well-defined nomenclature in diagnosing the heredity, but we must also take the number of members of the family and the number of relatives into account in a statistical calculation.

These statements are also applicable to divergent squint (72 cases). Here too, the number of females is significantly higher than that of males and there is no difference in frequency between the right and the left eye.

Concerning refraction, a statistical analysis of the converging squinters (322 cases) yields the following result:

> Independent of the duration of squint I did not find any clear correlation between squint and refraction, measured under atropine mydriasis. Thus the degree of hypermetropia does not seem to be in concordance with the duration of squint. In fact, since hypermetropia decreases gradually after the fourth or fifth year of life, one might expect that in children with hypermetropia who develop squint at a very early age, the hypermetropia would improve while strabismus is being established.

In my cases I have measured the refraction under atropine mydriasis, added one diopter, and determined the spherical equivalent of it in order to be able to make a comparison with the study of hypermetropia found by Brown and Slataper. There appears to be a great conformity between my values and those of Brown and Slataper, whereas in my figures, too, a gradual rise in hypermetropia appears to take place as the patient gets older, up to the fifth or sixth year. My conclusion from this statistical analysis is:

> It does not seem likely that the refractive error has much influence on the origin of convergent strabismus. This conclusion is supported by a similar analysis when you divide the cases according to isometropia and anisometropia. In the latter group there is strikingly little difference between the average refractions of the fixing eye and the squinting eye, namely, about 0.60 diopters.

Therefore, in looking for the cause of convergent strabismus we may no longer consider the influence of the refraction only, certainly not in the unproved cases of accommodative squint. In view of this analysis I am almost convinced that refraction does not play a preponderant part in all cases of nonaccommodative squint. In my opinion, accommodative strabismus is characterized by a manifest hypermetropia of more than two diopters and a lack of anisometropia.

It is no news to you that in cases of convergent strabismus the amblyopia is more severe with early onset of squint. Nor is it news to you that only a few instances of severe amblyopia are found in cases of divergent strabismus. It is a new and surprising discovery, however, that statistical analysis of the results of the treatment of amblyopia would indicate that better success is finally achieved when amblyopia is greater at the beginning of treatment (of course we must exclude the cases of eccentric fixation).

It is my habit to divide cases of squint into the following groups (of course these groups have their subdivisions):

I. Strabismus Convergens
   1. With normal junction (correspondence)
   2. With abnormal junction
   3. With eccentric fixation

II. Strabismus Divergens
    1. With normal junction
    2. With abnormal junction
III. Strabismus Accommodativus
IV. Heterophoria
V. Amblyopia

I place in the group of abnormal junction all cases with subjective angle and with a regional suppression combined with a false projection.

I should like to illustrate by means of graphs the distribution of 433 cases of converging squint and 36 cases of diverging squint according to age at onset of strabismus.

The abscissa in figure 1 is arithmetical. Many authorities make the objection that this division does not give the biological meaning of the different years of life. In order to frame a biological abscissa I have

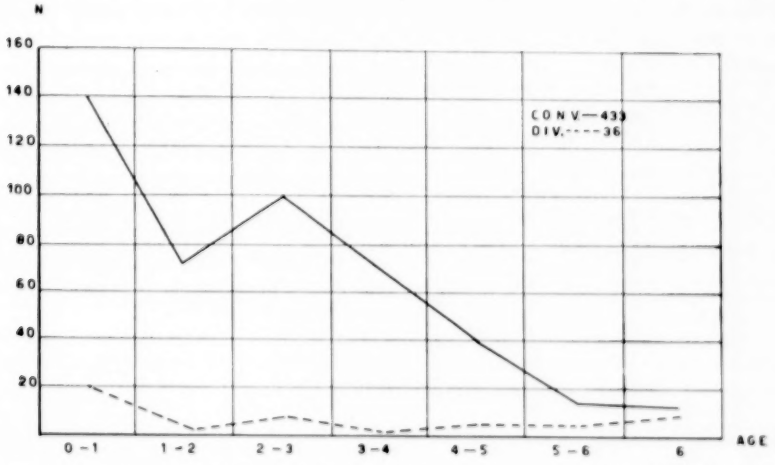

FIG. 1—Convergent and divergent strabismus. Abscissa indicates age at onset of strabismus in years; ordinal indicates number of patients.

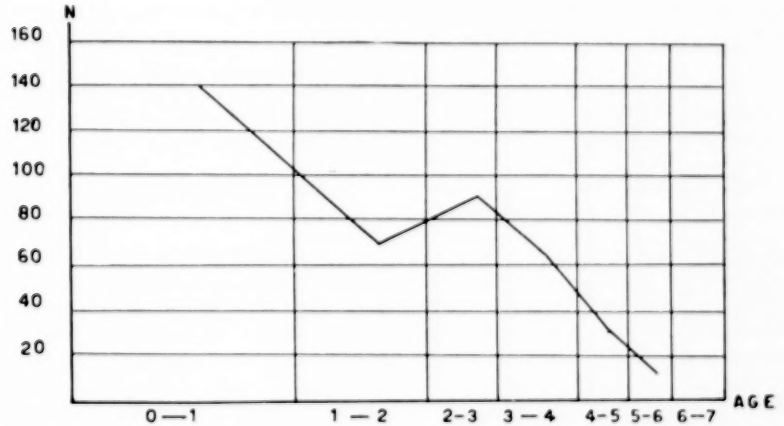

FIG. 2—Convergent strabismus. Same cases as shown in figure 1, with abscissa revised to indicate biological age.

compiled data regarding the height, weight, and width of the chest according to Schlesinger, and I have calculated the average of this bundle of curves. Then I have straightened out this average line and adapted to it the division of the abscissa. Based on this new "biological" abscissa I find that there is no real change in the form of the curve of frequency (fig. 2). This curve suggests that there may be an increase in the number of converging squinters during the third year of life. In order to test this, the material may be worked out in a so-called cumulative way:

a. Absolutely, indicating the numerical increase of each group (fig. 3).

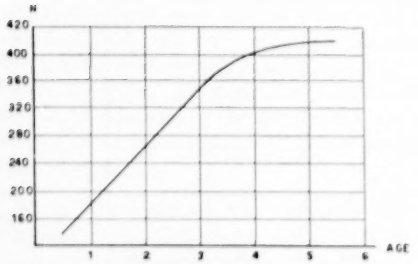

FIG. 3—Cumulative graph showing the number of cases of convergent strabismus relative to age.

b. Proportionally, indicating the increase by percentages. It is surprising that a straight line now appears, which agrees with the so-called "normal distribution" (fig. 4). For comparison, the values found by Keiner are shown in the same figure.

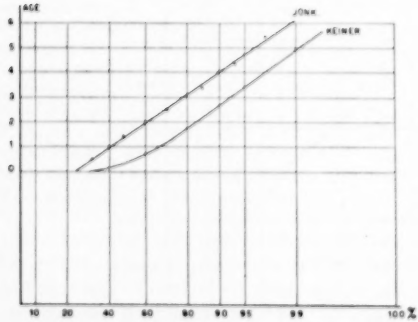

FIG. 4—Figure 3 expressed in terms of cumulative percentages. Values found in a study by Keiner have been added for comparison.

An analysis of Keiner's figures indicates that squint most frequently starts during the first year of life. It is not yet clear why our figures vary.

I wish to present an analysis of 523 cases of converging squint, divided into the three groups mentioned above. By this analysis it can be demonstrated in a statistical way that the top of the frequency curve of converging strabismus with normal correspondence (3 years and 2 months) differs significantly from that of converging strabismus with abnormal correspondence (1 year and 2 months); the top of eccentric fixation is found to be at eight months of age (fig. 5). This analysis indicates to me that the deviation of binocular vision is greater as the onset of the squint is earlier, for the best therapeutic successes are scored in cases of strabismus with normal junction, and the worst in cases of strabismus with eccentric fixation.

This leads to the discussion of the therapeutic results.

From 750 cases of strabismus seen during five years, 25 cases were selected in which the best possible conditions existed for the development of normal binocular vision without orthoptics. A cure resulted in 15 cases, of which 5 were treated surgically and 10 were not. The occurrence of "spontaneously" cured cases of strabismus, even when one takes into account unrecognized cases, must therefore be estimated as very infrequent.

The results of treatment with orthoptics in 137 cases of strabismus are presented in table I.

I believe that the ophthalmologist should treat strabismus in the following way: The appearance of an eccentric fixation and abnormal correspondence must be prevented at any cost, that is, all strabismus must be treated as early as possible with complete occlusion, whether the occlusion be alternating or not, if we are to obtain

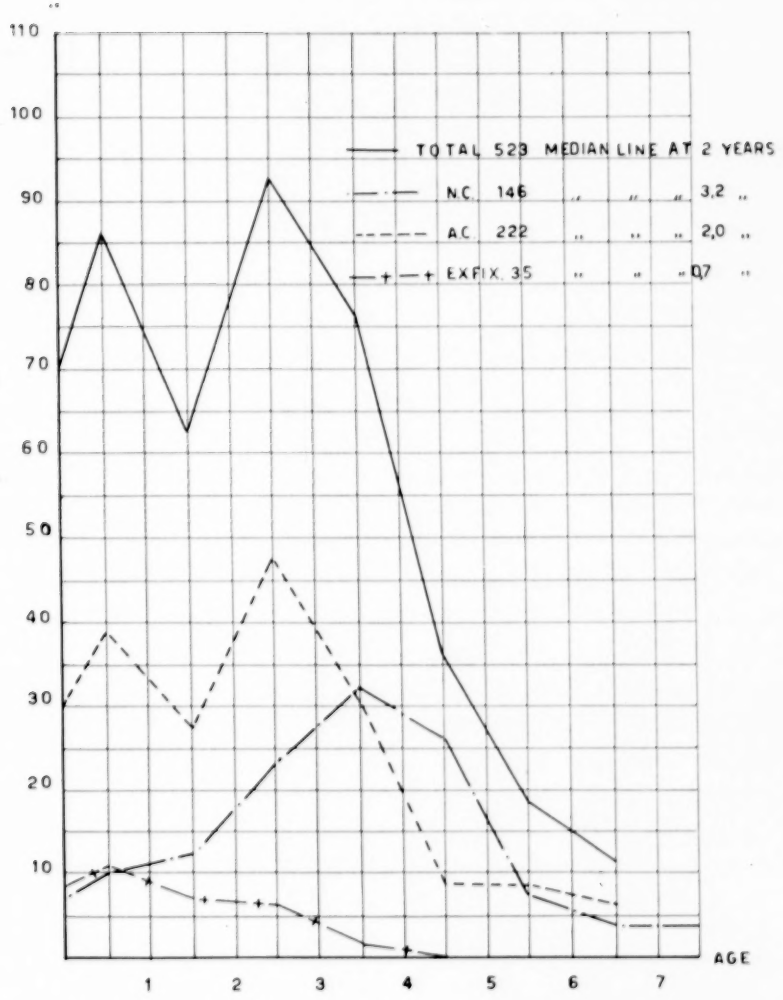

FIG. 5.—Convergent strabismus in relation to correspondence and eccentric fixation.

our minimum goal of foveal fixation. The prescription for glasses must be determined by tests under atropine mydriasis, and such glasses must be worn constantly. If the fixation is not foveal or can be made to become foveal, the best treatment is occlusion of the squinting eye until the child is old enough to be treated in the way indicated by Bangerter. All these treatments should be continued until (1) the child can see equally well with each eye and (2) the child is old enough to be trained binocularly. It is recommended that this binocular training be deferred until the sixth year of life, because binocular exercises will often have to appeal to qualities and, even more important, to an attitude acquired only at school. In my opinion, surgical adjustment

TABLE I

STRABISMUS TREATED WITH ORTHOPTICS*

DIAGNOSIS	TOTAL NO. OF CASES	CURES WITH POSTOPERATIVE ORTHOPTICS	CURES WITH PREOPERATIVE AND POSTOPERATIVE ORTHOPTICS	CURES WITH ORTHOPTICS ONLY	TOTAL NO. OF CURES	PERCENTAGE OF CURES
Strabismus convergens with normal correspondence	42	2	12	7	21	50
Strabismus convergens with abnormal correspondence	65	3	5	2	8	12.3
Strabismus convergens accommodativus	8	0	0	6	6	75
Strabismus divergens	22	0	4	10	14	63.6
All cases	137	5	29	25	59	43

*Cases with heterophoria and amblyopia are not included.

completed long before binocular exercises can be started is entirely superfluous. Unlike Keiner, I have seen no complete spontaneous recovery from any form of strabismus before the patient is six years old, except for some cases of the purely accommodative type. No doubt, the line of action mentioned here and applied consequently will be the cause of a considerable increase in the percentage of recoveries, provided a number of psychologic and pedagogic factors are taken into account.

These considerations I should like to present to you now. I suppose that all of us often have had cases in which by training, whether or not combined with surgical procedures, we bring the eyes of our patients into an ideal state, at least in our opinion, to begin to see in a real binocular way. After a short time the optic axes have become almost parallel, and we have created a proper fusional-amplitude and even a beginning of stereopsis. All binocular feats are performed without any mistake. However, after the patient has left our office his eyes are again convergent or divergent, because, as we say, one eye is suppressed. Apparently, we don't succeed in curing these patients. One might say that there exists something like a "horror uniplopia." On the other hand, we have all had a number of children who experienced an unexpected improvement—even good results—when we have continued the training long enough.

But what part does the skill of the orthoptic technician play in the training, and what part do the surroundings where the training takes place play? What part does the social world of the child play? Are the results influenced, for example, by the personal relation between the orthoptic technician and the patient? None of these questions has been answered, and I am convinced that up to now we have not tried hard enough to answer them.

We are too much inclined to consider the building up of a spatial world as an intellectual process of learning resulting only from optical stimuli. Because of this attitude we are inclined to isolate binocular vision and even to ascribe to it an absolute function, the only one by which the spatial world would be built up. I am convinced that this way of thinking is inconsistent with the history of the development of the child's perception of space. It is true that the "organon visus" is initially incomplete as a monocular organ, wherefore we must further assume that the two eyes have no junction at birth. But he who thinks that the building up of the world of space is due only to optical stimuli is mistaken. The new-born child lives

in a world which is a perceptive unity without differentiations. There is not as yet a distinction between stimuli of optic, vestibular, kinesthetic or tactile kinds. Gradually, in the course of years, differentiation of appreciation and order comes into being, but this differentiation never reaches the absolute phase. The visual perception of space is never an isolated thing, outside the person, not even with grown-ups; it is always part of the total sensory perception. This consideration implies a serious objection to our modern orthoptic technique. As I have already pointed out, in our practice of orthoptic treatment we have isolated the binocular vision from the integral, complex perceptive unity of the child, and as reasoning grown-ups we have brought it into line with our view and our appreciation. From this "technical" point of view we have designed orthoptic training; and now we are surprised at our inefficient and inadequate results. I believe that we do not realize just how difficult orthoptic training is for children and just how little this therapy is adapted to the child's world of interest and emotional appreciation.

It seems to me that we are dodging the issues presented here. Why were we not successful in one case in which the prognosis seemed to be favorable, and why did we have success sometimes in another case in which the prognosis seemed to be less favorable? I can't give you an answer to these and similar questions. Neither have I heard or read them anywhere. And yet, if we want to improve our therapy, we will have to face these problems, and we will have to dig deep into the essence of binocular vision. What is the meaning of the frontal position of our eyes? Physiologically, it provides the possibility of building up a binocular visual field with such qualities as simultaneous perception, fusion, and stereopsis; but what is the psychological, the existential, aspect of it? What is the meaning of the fact that man walks upright and can look others full in the face? What does it mean when a person begins to squint and can no longer "meet" visually his fellowman?

With an understanding of the development of binocular vision, we may, from a physiological point of view, assume that it does not matter to the child whether it grows up using one or two eyes. There is no stimulus which, in itself, makes the child see with two eyes instead of one. Have you ever heard a child boasting, "I can already see with two eyes"? A positive appreciation of the most subtle differentiations of binocular vision probably is acquired during the age period in which strabismus only rarely occurs. Before that time the spatial interest of the child is directed only to his own body and its immediate surroundings and is strongly influenced by its vital needs; it is during this period that most cases of squint begin. What is the meaning of this fact? Could it be possible that in the child who has started to squint there is initially a disturbed development of the emotional relations and squint begins as a result of this disturbance; that owing to this, people and circumstances cannot be looked full in the face? For we see that grown-ups in an abnormal state of mind act according to particular patterns of behavior, in which they revert to an earlier genetic level. These reactions may be "short-circuit actions." In the realm of binocular vision, falling back to an earlier genetic level may result in monocular vision.

Is it not possible that the primary cause of many cases of strabismus is a disturbed relationship to the environment, a disturbance partially or completely stopping the development of the differentiation of the world of perception and preventing the existential experience of looking the world full in the face? I mention these reflections on the problem of the origin of squint, not only for their scientific value but also for their possible significance in orthoptic training. Besides what I have suggested as ophthalmological desiderata in our orthoptic treatment, I believe that orthoptic

training will have to be only one part of the therapy aiming at the re-education of the entire sensory perception; moreover, we shall have to be guided and instructed by psychologic analyses and advice, and we must encourage the parents to participate in the therapeutic process. This means that, in every case, we shall have to integrate our orthoptic training with physical and psychological therapy, so that the binocular observations are integrated into the child's normal and complete perception of the world. No doubt we shall need the help of child psychologists and sometimes psychiatrists.

I have already made a modest start in this respect. From my patients with strabismus, I have selected an equal number of boys and girls for examination by a psychologist. As time goes on, I shall report the results.

The plan which I have outlined as an ideal—an ideal, however, which can surely be realized—will be very expensive. But is any cost too great for the relief of the suffering of so many of our children, especially when we realize that the maladjusted children of our day may be a problem of tomorrow? Therefore, I want to make an appeal to you. America has been forced to assume a preponderant position in the world and has shown in many instances that it knows what it means to accept this responsibility. I am asking you most urgently now to give your full attention to the progress of scientific research in the field of orthoptic training in the direction which I have tried to indicate roughly.

PRACTICAL ASPECTS OF TEMPORAL AND NASAL OCCLUSION IN TREATMENT OF STRABISMUS

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IN the American Orthoptic Journal, 1953, Angela Swenson introduced to us a method of partial occlusion of the deviating eye which I believe already has proved itself very valuable in teaching binocular use to strabismic eyes.

You may recall that temporal occlusion of the deviating eye was initially used on eccentric fixators or deeply amblyopic patients. Since most eccentrically fixating and amblyopic eyes are convergent deviators, the parallel rays of light fall nasally to the macula, and the occluder is applied over the temporal half of the lens. One can experience suppression caused by such extraneous glare by artifically producing diplopia and then shining a bright light, such as a flashlight, into the deviating eye. One can be aware of the disappearance of one of the images, perhaps not constantly, but intermittently. Similarly, with a constant deviation in which there is diplopia, consciously or not, the parallel rays of light fall beside the macula of the nonfixing eye and apparently cause enough disturbance to interfere with the function of the macula, so that it is suppressed. The depth or intensity of the suppression depends on various determining factors, such as the age at onset and refractive errors.

If the vision has deteriorated so that fixation is eccentric, or very poor, the patient is much happier to begin occlusion in this less distressing manner, which excludes only the disturbing rays of light from the deviated macula. This is done by covering the lens just over the pupillary reflex. If the visual acuity is very low, the entire temporal area of the frame should be covered with a cone-shaped occluder to exclude all light from that direction. By removing, or blocking, the sources of irritation, the macula is alerted and stimulated to function again. When fixation and vision have recovered enough so that binocular work can be done on the amblyoscope, complete occlusion is begun.

While we were using temporal occlusion in this capacity, it coincidentally became apparent that some changes were occuring in the fusion derangement. The areas of suppression, measured on the troposcope, were found to decrease with temporal occlusion and to increase again when complete occlusion was used. Since all fusion difficulties (abnormal retinal correspondence) are basically due to suppression of various intensities, this change seemed to indicate that the initial step toward breaking down this suppression had been taken. Again, suppression is a phenomenon of binocular vision and not present when one eye is exposed alone; therefore, it is difficult to understond how complete occlusion can eradicate suppression and abnormal retinal correspondence. Complete occlusion is certainly indicated for final treatment when amblyopia is present. With temporal occlusion, the wrongly stimulated area of the retina is covered and the dormant macula is given an opportunity to live and work. The moment the patient has a conscious awareness of diplopia, the higher nerve centers will try to do something about coordination and fusion when given an opportunity. Alternating esotropes have always been a problem for orthoptists; however, we have had a number of them who

Read at the Thirteenth Annual Meeting of the American Association of Orthoptic Technicians, September 20, 1954, New York City, N. Y.

responded favorably to this type of occlusion.

Miss Swenson had limited her use of half-lens occlusion entirely to temporal occlusion. We had a number of highly divergent squinters. Two of these patients showed deviations as high as 40 prism diopters of exotropia and had no conception of binocular skills; therefore they had very poor interpretation of correct diplopia. I then dared to use nasal lens occlusion. While the task seemed hopeless for a time, these two patients developed fusion in less than three months; and once fusion was established, fusional amplitudes were easily developed. I do not mean to imply that surgery is eliminated by nasal lens occlusion, but fusion is much stronger, fusional amplitudes develop faster, and, last but not least, recurrence of the difficulty is less frequent. I feel very strongly that children with exotropia and divergence excesses will benefit from nasal lens occlusion, not only as an immediate result but particularly over a period of years. Convergence insufficiencies usually present little difficulty. The time for such occlusion varies with the deviation and with the individual's efforts. For some of these patients we used occlusion for only four weeks, and rarely did we extend the time longer than eight weeks. Regardless of the actual deviation, when suppression has been eradicated completely the patient can learn to maintain fusion beyond his position of rest and will have a normal range of convergence. If, then, he cannot maintain parallelism without help, there is no need to fear overcorrection by surgery.

Finally, we found that suppression is a problem also in the vertical deviations. Vertical deviations which are too large to be corrected by prisms have been stabilized by the use of occlusion on the lower half of the lens when the dominant eye is lower. The occlusion cannot be applied to cover the pupillary reflex, since that would completely occlude that eye in the reading position. Only a portion of the lens is occluded, which gives the desired protection in the reading field. Vertical occlusion may be used in conjunction with temporal occlusion so that only one-fourth of the lens is clear for vision. The vertical deviation becomes stabilized and, usually, reduced so that a prism correction can be used if the patient has not learned to control it without such help.

While each patient has his peculiar problems and makes adjustments according to his own abilities, we have found many children with visual acuity of 20/50 who respond well to temporal occlusion and binocular therapy without the need for complete occlusion.

Supplementary home exercises are a most valuable adjunct to temporal occlusion. Even when visual acuity is very poor, or when no fusion is present, fixation and localization exercises can be carried out. With the red kodaloid over the dominant eye, the child, while watching television or a lamp, can (1) find the red screen, then the white screen, alternately and (2) learn to localize properly the two colors in space. Stressing particular interest in the white image stimulates both vision and the macula for binocular use (fusion).

A parent frequently complains that the eyes seem turned more or that the good eye now turns in. The child turns his head so as to use the half-occluded eye for casual fixation, which produces this appearance. As orthoptists, we find this a most valuable sign, since we have accomplished the goal of converting the deviating eye to a useful eye.

When patients have not been given a refractive correction, we have obtained inexpensive, but properly fitting, frames from the optician to use in partial occlusion. This is necessary most frequently for cases of exotropia when the refractive error is slightly hypermetropic. A base of clear scotch tape is applied to the frame and then covered with opaque masking tape.

The size or width of the occlusion is measured by having the child fixate on a fixation light, at which time the reflex of the deviating eye is noted and marked in some manner until the masking tape can be measured and applied to just cover this reflex. In cases of divergence excess, the reflex should be marked while the patient fixates a distant object.

It is important that this occlusion be worn constantly to derive proper benefit. It should be continued until fusion is stable and some fusional amplitude has developed. If surgery is indicated but cannot be done immediately, it is best to continue occlusion, since the old habits may be resumed.

CASES

W. R., age 6
Deep Amblyopia
O.D. 10/77; Rx: +3.25 △.50×90
O.S. 20/20; Rx: +2.50
Temporal occlusion begun on O.D.
One month, 3 sessions: Vision O.D., 20/100 (complete occlusion)
Plus 2 months, 7 sessions: Vision O.D. 20/50 on full line, 20/30 single letters, stable fusion.
Plus 1 month: Still has some esotropia and vertical deviation to correct before doing fusion homework.

S. H., age 4, Rx: O.D. +1.00
Rx: O.S. +1.25
Esotropia, Equal Visual Acuity (Emotional)
With glasses
Cover Test: distance, E-ET 60△; near, E-ET 70△
Temporal occlusion, O.D.
Four sessions: Fusion stable
Plus 7 sessions: Fused at near off machine
Plus 12 sessions: Good amplitude off machine with filter
Temporal occlusion continued 9 months because of instability when new problems arose.
Results good after one year.

L. G., age 5
Exotropia
Vision, O.D., 20/80; Rx: +1.50
Vision, O.S., 20/80; Rx: +1.50
Cover Test: distance, 32△ exotropia; near, 37△ exotropia
Superimposed unstably; much blinking and constant frowning
Nasal occlusion: 15 sessions over 5 month period
Two months: Aware of diplopia at home, fused well at objective, converged to 10△ base out
Off training 8 months, continued nasal occlusion
Vision, O.D., 20/20
Vision, O.S., 20/20
Cover Test: distance, 21△ exophoria; near, 12△ exophoria
Loose Prisms: distance, 18△ base out; near, 30△ base out
No frowning except while working; generally much happier; training resumed to develop better fusional amplitude.

T. K., age 4; No Rx, O.D. dominant
Exotropia; Original Esotropia
November 1952, Recession of left medial rectus and resection of left lateral rectus
December 1953
Vision, O.D., 20/30
Vision, O.S., 20/30
Cover Test: distance, 18△ exotropia; near, 25△ exotropia
Troposcope: 20△ exotropia, obj.; much suppression, O.S.
Nasal occlusion, O.S.
Eight months, 16 sessions (every two weeks): Holds eyes quite straight
Loose prisms: distance, 18△ base out, 18△ base in; near, 50△ base out, 18△ base in
Troposcope: Converged 60△ base out.
Occlusion off indoors only if he keeps his eyes straight.

G. R., age 7, Rx: none
Vertical Deviation
Visual acuity equal for both eyes.
Distance, 30△ left hypertropia; near, 38△ left hypertropia, 4△ exotropia
Vertical and nasal occlusion begun first visit.
Two months later gave prism correction: O.D., 6△ base up; O.S., 6△ base down.
Nasal occlusion.
Plus one month, fused homework.
Total 10 months, 16 sessions.
Loose prisms: Without filter, distance 26△ base out, 6△ base in; near, 40△ base out, 7△ base in. With filter, distance, 16△ base out; near 30△ base out.
Vertical deviation interferes on high convergence.

SUMMARY

A. Partial Occlusion in Suppression Amblyopia and Eccentric Fixation
   1. Very helpful for patient with eccentric fixation, since he has much difficulty, even out of school, with complete occlusion
   2. Eases the patient into therapy and occlusion without emotional trauma
   3. Prepares a state of readiness and acceptance for complete occlusion if and when indicated
   4. Helps to eliminate suppression by eliminating active stimulation of noncorresponding retinal areas
   5. Facilitates promotion of binocular activity as soon as vision permits

B. Elimination of Suppression
   1. Necessary in treatment of
      a. Small deviations and borderline tropias
      b. Suppression at objective angle
      c. Abnormal retinal correspondence
   2. Obtained by
      a. Partial occlusion, by interrupting the stimuli to the noncorresponding areas of the deviating eye, thus permitting and encouraging the macula to become active
      b. Partial occlusion together with binocular exercises at the casual level
      c. Arousing normal diplopia responses at the casual level
   3. As a valuable adjunct to preoperative training

True, complete occlusion cannot be discarded. It does not break down binocular suppression already there, it can only prevent more. We must rectify the past damages.

OUR EXPERIENCE IN ESTABLISHING ORTHOPTIC TRAINING IN BRAZIL

MOACYR E. ALVARO, M.D.
SAO PAULO, BRAZIL
BY INVITATION

WHEN I was asked to appear on the program of this gathering, I decided to talk about the establishment of orthoptic training in Brazil. One reason for this decision was the advantage of comparing notes on the problem of establishing organized orthoptic training in countries as different as the United States and Brazil, and another was that our experience may be of help to many groups in the world which, sooner or later, find themselves confronted with a similar problem.

When we consider the large number of ophthalmologists in the world today who are giving their services to hundreds of millions of human beings and who do not as yet have adequate facilities to treat their strabismus patients, it becomes obvious that we should give these men the results of our experience in trying to establish, in an organized way, a method of treatment we all know is essential, so that they may be encouraged in trying to do the same thing.

In the first place, it is necessary that all people concerned in each community should understand the prevailing ideas of the treatment of strabismus. If such education is not undertaken, the establishment of training facilities will be of little use, and trained personnel will have no field in which to operate.

Who are the people who should be made aware of the problem?

Of course the ophthalmologists should be considered first. I remember how after returning from the XIV International Congress in Madrid, enthusiastically imbued with the new approach towards the treatment of squint, I found it difficult to talk to my senior colleagues, who frowned on these "new fangled" methods which were talked about. Some proselytism had to be made. Some of the older men had to be cajoled and humored into talking the same language. Paper after paper had to be read before the different ophthalmological societies, stressing the importance of the new ideas.

Talks to groups of doctors in other branches of medicine, especially pediatricians, were also necessary for two reasons: first, if we were to expect parents to accept methods of treatment entirely foreign to them, it was essential to have the backing of the family's or the children's doctors; second, our own colleagues were becoming interested in the "new" ideas, hearing of them through the grapevine and through their cronies, the pediatricians or general practitioners, who asked them about these methods of treatment. I recall having several colleagues, some my seniors, accost me and ask where one could procure an amblyoscope because they had been pestered by pediatricians who insisted on having their little patients treated by these modern methods.

The third group to be approached were those directly responsible for the child's education. This included school teachers, the Parent-Teacher groups and, above all, the medical inspectors in the schools. The subject, of course, lends itself to a dramatic approach which should not be neglected. Anyone will easily understand that a cross-

Read at the Thirteenth Annual Meeting of the American Association of Orthoptic Technicians, September 21, 1954, New York, N. Y.

eyed child has an inferiority complex, and consequently something should be done to correct this disfiguring defect.

It is difficult, however, to make the parents understand that orthoptic training is intended not only to correct the physical appearance but, chiefly, to establish simultaneous binocular vision, with all its advantages.

To help people, in general, understand this, we found the simple demonstration of binocular vision being essential to depth perception very effective. Many of us gave talks before different groups where we asked for two persons at a time out of the audience. One held a pencil, vertically, point down. The one being tested held another vertical pencil, underneath, point up. He was told to touch the pencil points, first with both his eyes open and afterward with one eye closed.

A similar experiment was exhibited for the Sao Paulo Medical Association, during the housewarming of its modern premises. Among the exhibits of the ophthalmological section was a table on which was attached a head rest with an eye occluder. Beyond, a pin was firmly stuck in the middle of the table and another pin was attached to a loose chain. Printed instructions of the test of touching the pin points were provided; the test was also explained by an assistant. People, by the thousands, streamed through the exhibition halls during the days for public visits, and that was the most popular exhibition because there was a large picture of a cross-eyed child and the caption, "Do you know what it means to be cross-eyed?"

By 1937, the ophthalmologists in Brazil were aware that there was something new in the treatment of strabismus, other than giving the patient glasses and eventually operating. It was then decided that the official subject for the next Brazilian Congress of Ophthalmology, to be held in 1939, should be strabismus, dealing with etiology, medical treatment, and surgical treatment. This happened because the patients themselves were learning about the new methods. Several of my colleagues told me that many of the parents of their squinting children had asked if they didn't think it advisable to occlude one of the patient's eyes, since they had heard that the daughter of Smith or Brown had had that done to her and was now much better.

In 1939, the formal papers on strabismus were presented and the tide turned. Officially, at least, it became obvious that there was another treatment than just glasses and tenotomies. Of course there were still many diehards. I remember that one of the men who was to give a report on the new treatment was cautioned by an older friend that it was too revolutionary to be read. He read the report, nevertheless, following it with the challenging words, "These are the ideas now accepted in the world today according to . . . ," and then the whole impressive list of names of prominent, internationally known authors in favor of the new method.

Gradually, more and more Brazilian doctors became interested in the possibilities of establishing facilities for orthoptic training in order that their patients could be adequately treated with modern instruments by properly trained technicians.

It was obvious to most of us that to have orthoptic training succeed, we should have technicians, not doctors, do the actual training. The doctor's too precious time would make the cost of the treatment prohibitive to most people. Some doctors, however, were doing it themselves though in a rather amateurish way, since they had not the proper training although they sometimes had a sound theoretical knowledge of the subject. And, of course, those doctors opposed the idea of having technicians, because they thought the training they were given was sufficient. Others were opposed to having technicians on the general principle that only persons with a doc-

tor's degree should be in charge of any form of treatment, in spite of the general practice in the offices of most doctors of delegating many forms of treatment to nurses and other technicians.

The war years, from 1939 to 1945, prohibited the establishment of orthoptic training, as such, in our country. On frequent visits to the United States during those years, I tried repeatedly to get a qualified technician who would come to Brazil and train a group of our girls who were already interested. At that time, however, the number of technicians in the United States was limited and it was difficult to find anyone willing to go.

Former experience had taught us that it was wiser to get a teacher to come to us than to send one or two of our qualified girls to learn here and return to Brazil to teach. One out of five of such girls sent here to study has returned only to marry and then give up her career. Another ever present risk is that a girl will decide to stay in this country.

Finally, we had the good fortune of having Sir Stewart Duke-Elder appoint a very well qualified technician to come to Brazil for a period of nine months.

Now the technician was available and several girls were interested, but that was not all. Who was going to finance the project? If only one group did it, and that would not be difficult to implement, the project would be partially doomed because other groups would naturally oppose. The project had to be backed by all groups concerned. Finally all the groups agreed to help in the financing. Actually, the expenses were largely covered by the tuition fees of the six students, some paid from their own pockets, others arranged for by the clinics who wanted an orthoptist's future services.

Of course, the group of students had been previously screened. They were required to have a college education or the equivalent and to understand the English language.

The first course was a success, and immediately after its completion, all the graduates went to work in different clinics. Miss Mayou, the British teacher, had brought with her a double set of instruments. Consequently, a few days after her arrival, in August 1947, it was possible not only to begin teaching but also to start the first orthoptic training clinic, which was established at the Ophthalmological Center of the Paulista School of Medicine in Sao Paulo.

Since then four other annual courses have been established; actually, they last around eighteen months. The schedule for the first nine months includes theoretical study with the practical advantage of doing the regular work of a technician under supervision. The last nine months of training are spent in different orthoptic training clinics.

As a result, there are now properly trained technicians in Brazil. Several people have come from the neighboring republics to take refresher courses, but, to my knowledge, there is no other place in South America where proper and organized courses for training in orthoptics exist.

The requirements for admission have remained the same. Candidates must show evidence of proper basic knowledge in medicine, in optics, in ophthalmology in general and in motility in particular. This is done by oral examinations, the examiners being ophthalmologists on the staff of the Paulista School of Medicine. Candidates are also examined on their proficiency in understanding English, since textbooks are, so far, only available in English.

There is, of course, no question about the excellent results of having orthoptic training introduced into Brazil. The figures showing the results with and without orthoptic training speak for themselves.

Another fact, the importance of which should not be neglected, is that more and more people now know that "exercises" might help them, and, consequently, demand them. This is accessory to making even the diehards realize they must provide orthoptic training or else.

Unfortunately, of course, unethical doctors will take advantage of the program and prescribe orthoptic exercises when there is no indication whatsoever for that kind of treatment. This is not only bad in itself but, in the end, it will have a demoralizing effect on the value of the treatment.

In Sao Paulo, I know of only one doctor who does orthoptic training without the aid of a technician. In Rio, the situation is quite different: several doctors handle their patients for orthoptic training personally.

Some technicians have created difficulties by wanting to establish themselves independently, which, of course, is against federal law in our country. They have also made efforts to change the legislation. We are coping with this by indoctrinating the students, during the course, with the idea that the ethical standing of a technician requires that she work always under the supervision of a qualified ophthalmologist. In the future we are going to require that they take an oath, upon graduation, that they will not do otherwise.

Technicians are in great demand. More and more ophthalmologists are seeking their services. In the near future, more orthoptic courses will have to be established in other parts of Brazil and in the neighboring republics. We feel that it is high time for the American Orthoptic Council to become Pan-American, so that the future development of orthoptic training in the Americas may be guided in the right direction.

COMPARATIVE STUDY OF AMBLYOPIC TREATMENT

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BY INVITATION

The incidence of amblyopia in the general population is very high; Downing (1945) found 1,920 cases among 60,000 selectees for the U.S. Army.

In childhood, amblyopia is often the reason for the inability of even intelligent children to succeed in school, and in some cases, especially those associated with myopia or extreme astigmatism, reading difficulties may be traced directly to this condition. In the field of sport, these children are again handicapped owing to their imperfect ability to judge distances correctly, and being discouraged by their lack of success, they tend to shun all forms of sport, with resultant ill effects on their general health.

In the child of school-leaving age the effects of ambloypia are again felt. It is at this age that a decision must be made as to which career will be followed, a decision of far-reaching importance, affecting as it does the child's whole future life. Many careers are these days open only to those with perfect binocular vision. The Army, the Navy, the Merchant Marine, the Air Force and civil aviation, and many employers in State and industry, especially in concerns where pension schemes operate, are becoming increasingly strict concerning the visual requirements of candidates.

In adult life this condition may also be the cause of much inconvenience. In cases in which the vision of the good eye is affected by accident or disease, wage earning capacity may be greatly reduced by the resulting visual impairment. To a lesser degree, with the onset of presbyopia, much trouble may be experienced in middle age, due to heterophoria, as there is always a tendency for an amblyopic or partially amblyopic eye to develop an exophoria.

In cases of strabismus the incidence of amblyopia is greatly increased. Basing our estimate on the study of 1,800 cases of strabismus, we have found that 61 percent of all cases of convergent strabismus exhibit degrees of amblyopia varying from the ability to distinguish hand movements, with loss of central fixation, to 9/10 vision. The incidence of amblyopia in cases of heterophoria and in divergent strabismus is less.

Thus, it is obvious that this condition should be treated as early as possible in life in order that education and work may not suffer. The general method of treatment, which has been in use for many years now, is occlusion of the nonaffected eye. Providing that the amblyopia is not of an intractable variety, such as an eccentric fixation, this method gives varying degrees of success in a variable period of time, depending on the degree of visual impairment, the age of the patient, and above all, his and his parents' cooperation. In the case of very young patients, the parents are often unwilling for the child to wear an occluder over a long period; in the case of the school-age child, his studies are often seriously interfered with for several months; and in the case of young people and young adults, economic and esthetic considerations render the wearing of an occluder for long periods impossible.

From the Ophthalmological Clinic of the University of Ghent; Director, Professor J. Francois, M.D.
Read at the Thirteenth Annual Meeting of the American Association of Orthoptic Technicians, September 21, 1954, New York, N. Y.

In view of all this, it is now generally agreed that occlusion alone is of doubtful value and is much more likely to meet with success if combined with some form of visual stimulation. Although not claiming any originality for the methods used, we have analyzed 200 cases of strabismus with amblyopia, chosen at random from the 1800 cases in our original study, in an attempt to prove this contention.

One hundred (group I) cases were used as controls: these cases were treated only by occlusion. The other 100 cases (group II) were treated by occlusion and visual stimulation. The results in the two groups are compared.

It may be of interest here to mention the methods used, which are similar to those used extensively in most orthoptic clinics. In both groups continuous total occlusion was employed, that is, occlusion of the nonaffected eye by adhesive plaster on the face until the vision of the amblyopic eye reached at least 4/10 or 5/10. In some cases this was necessary until the vision was further improved, owing to the fact that the children could not be trusted to wear continuously a removable form of occluder. When vision had reached this stage, the adhesive plaster was replaced by an occluder made of zinc oxide plaster. This was fitted very exactly over the spectacle frame, covering the eye completely above and below and at the sides. Experience has shown that ready-made occluders, such as plastic clip-on occluders and rubber occluders, are not successful, for in most cases these do not fit well enough and the child nearly always finds a way of cheating. In cases of 9/10 vision or better, and in the treatment of suppression or to obtain alternation, a matt glass was substituted.

In the group in which exercises and occlusion were combined, the patients received treatments lasting one hour as frequently as possible. Ideally, this should have been every day or even twice daily; but in nearly all cases this was economically impossible, and generally the treatment was given twice weekly.

In the clinic the patients were treated by means of a major amblyoscope, equipped with flashing and oscillating devices, and the use of slides with images graduated in size and detail according to the visual ability, age, and intelligence of the patient. It cannot be stressed too strongly that continual supervision was here necessary; otherwise, in most cases, no effort was made by the patients, many of whom were very young. In fact, the youngest patient treated was only 2½ years old. Projection of both motion picture film and stills was used, which gained and held the attention of all ages. Jigsaw puzzles with pieces of various sizes graduated according to the vision and ability of the patient, and colored blocks and beads for the very young were used. Tracing pictures, threading colored beads, copying drawings, writing and figuring all helped the coordination of hand and eye in the case of school age children. In cases in which the visual acuity was too low even for the simplest of these tasks, the children were encouraged to locate the position of colored lights and pictures in a darkened room. The parents were encouraged to continue this treatment, so far as possible, at home.

The difficulty, we find, has been to find training materials with sufficiently minute detail as, once the vision has improved above about 5/10, very small images are discerned at close distances, and the principle is that once a task can be easily accomplished, it ceases to be of value as an exercise. This was particularly noticeable in the age group from 4 to 6 years, at which age most children are sufficiently intelligent to discern very small detail but are not yet capable of using material employing letters or figures, as was used for the school-age groups.

In group I, treated by occlusion only, 97 percent were 12 years of age or younger, 20 percent being under 5 years; in group II, treated by occlusion and vis-

ual stimulation, 88 percent were 12 years of age or under, 18 percent being under 5 years. Therefore, roughly speaking, the age groups were similar for purposes of comparison. The methods used for testing the vision were a standard test type at 5 meters for those able to read letters and figures, and the illiterate E test for those unable to read. The E test was found to be reliable even for the youngest patient treated.

The results obtained were as follows: The average vision before treatment was 3/10 for group I and 2.8/10 for group II. The average vision after treatment was 9/10 for group I, and 8.7/10 for group II. The number of patients in group I who attained a perfect visual acuity (10/10, or 9/10 in cases where the vision in the other eye did not exceed this vision) was 80 percent; in group II the number was 74 percent. We think that this difference was due to the fact that group II contained 9 percent more patients over the age of 12 years than were in group I, and that in these cases it was much more difficult to obtain a good vision because the amblyopia was of much longer standing, the onset of strabismus being generally at less than 3 years of age. It was also very noticeable that when the patient was over 12 years of age, the field of central suppression was much more dense and much more difficult to eradicate. In many cases the patients read easily the first and last groups of letters on a given line on the test types, while the middle letters were not discernable. In some cases the whole line could only be seen at 7/10 while the outer groups of letters were readable to 10/10 or even 12/10 vision.

The point of greatest interest, however, was the comparable time taken by the two groups to reach a maximal visual acuity (fig. 1). In group II, in a period of 4 weeks, 68 percent of the patients had attained their maximum vision, whereas in a comparable period only 18 percent of those in group I had reached maximum vision.

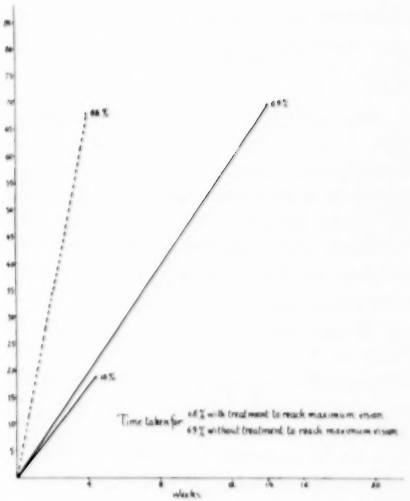

FIG. 1—Number of cases in group I (solid line) and in group II (dotted line) which reached maximum vision within certain periods of time. The shorter solid line indicates the percentage of cases in group I which obtained maximum vision within a four-week period.

In group I it required 14 weeks for 69 percent of the cases to reach maximum vision. In group II the longest period of treatment required was in the case of a child who was treated for 10 weeks; in group I one patient was treated for 15 months before reaching maximum vision! This was, fortunately, an exception, but several patients in group I were treated for six months or more.

In group I, as mentioned above, 80 percent of the patients finally reached a vision of 10/10 (or 9/10 when the vision in the other eye did not exceed this) and in group II, 74 percent.

Together with these figures it is interesting to note that the incidence of eccentric fixation (vision generally improved to between 1/10 and 3/10, but no more) was 2 percent in group I and 1 percent in group II; the incidence of intractable amblyopia (vision not improved beyond 7/10) was 13 percent in group I and 17 percent in group II; and the incidence of

complete lack of improvement in vision was 2 percent in group I and 1 percent in group II.

The similarity between the results obtained in the two groups seems to prove conclusively that whichever of the two methods is employed, the end results will be about the same, but the time required to obtain these results will be substantially reduced if occlusion is combined with some form of regular visual stimulation under constant supervision. Thus, much time is saved, the patients are spared many weeks of boredom and discomfort, and it is possible for further treatment of the strabismus, by either surgery or orthoptics, to be undertaken as soon as possible even in the case of very young patients.

We believe that this treatment might also be profitably employed in those cases where a maximum visual acuity is not obtained owing to the intolerance of the patient to a high or unaccustomed myopic, astigmatic or hypermetropic correction, but a sufficient number of such patients has not as yet been treated to permit us to form a definite opinion on the subject.

SUMMARY

We have compared two groups of amblyopic patients, 100 in each group, chosen at random from 1800 cases of strabismus. The cases in the first group were treated by occlusion only and in the second by occlusion combined with visual stimulation exercises. We conclude that the end results are the same but that the time taken to achieve maximum vision is greatly reduced by means of occlusion and exercises combined. In 4 weeks, 68 percent of the patients treated by occlusion and visual exercises reached maximum vision, whereas it required 14 weeks for 69 percent of the patients treated by occlusion only to reach maximum vision. We assume that this time could be even further reduced if daily treatment were possible.

WALRAVEN BAR SEPARATOR TECHNIQUES IN RELATION TO SINGLE BINOCULAR VISION

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IN discussing techniques for use with the bar separator, let us first consider some aspects of binocular functions and why certain emphasis is given to bar reading. Generally, in the orthoptic field, achievement of bar reading is regarded as one of the standards for the cure of strabismus. In our practice, bar reading is the goal for patients with convergence and divergence insufficiencies as well as for those with convergence excesses. From the beginning, training is undertaken with the prospect of single binocular reading. It is hardly necessary to state that all cases do not reach this goal, nor is it advisable for every patient to make the attempt. We are concerned here with the opportunities offered and the reasons for trying to achieve this desirable state.

It has been our experience that attainment of equal visual acuity, normal retinal correspondence, fusion, and parallel alignment of the eyes does not constitute a cure. Ten years ago, in the re-examination of cases that had been dismissed and were returning for periodic check-ups, we found disappointing results. There were varying degrees of suppression, diplopia, alternation, insufficient fusional range, amblyopia, and esotropia for near. In the majority of cases, the surgical results were successful but the functional results gave only a casual binocular vision for distance. This type of binocular vision does not allow a child natural use of the eyes, and this disadvantage increases each year as more detailed near work becomes necessary.

The lack of single binocular vision can make a difference in an occupational choice. Many corporations now require eye examinations for their employees for determining the type of work they can do. Today, we are all conscious of the three-dimensional trend in the entertainment field. Realizing our responsibility to the patients who come to us for correction of squint, we offer them the opportunity for and the possibility of developing single binocular vision.

The length of time usually required for developing single binocular reading was surprising at first, until we considered the development that is necessary for this accomplishment. However, the time element varies at this stage of training more than at any other, depending largely upon the individual's classification, efforts, motivation, desires and maturity. Orthoptic training is subjective throughout, and the attainment of single binocular reading is a greater subjective response than any other achievement during training.

The ophthalmologists who expect spontaneous fusion, postoperatively, from their squint cases are depending upon parallel alignment of the eyes to produce fusional development. This might be a satisfactory means of developing single binocular vision if it were not for suppression, residual deviations, innervational factors, and the lack of development of the binocular accommodative convergence association. Usually, orthoptic training is required for correction of these errors. Increasing fusional range and developing the vergences are not entirely orthoptic problems; for if the range cannot be increased sufficiently with orthoptics, surgical intervention can be undertaken.

Read at the Thirteenth Annual Meeting of the American Association of Orthoptic Technicians, September 21, 1954, New York, N. Y.

We encounter our greatest orthoptic problems when attempting to develop bifoveal fusion and a normal relationship of binocular accommodation and convergence. Much has been said about dissociation exercises in accommodative squint. Dissociation practice is equally as important in nonaccommodative squint, that is, in training toward the development of a normal relationship of convergence and accommodation.

Some of our most successful single binocular reading results have been in cases of nonaccommodative alternating esotropia. The age factor is especially important in attaining single binocular vision in these cases. One of the reasons that we do not favor early surgery is that the immediate advantages of postoperative training are lost if the child is too young. Following the most successful surgical operations and with the smallest residual deviations, the patients with nonaccommodative squint, especially alternators, usually suppress for near. This does not encourage bifoveal vision and/or bifoveal fusion development. A patient with nonaccommodative squint who has only a surgical correction at two years of age has possibly three or four years for the establishment of a suppression pattern, at least for near, before intensive orthoptic training can successfully be instituted. Unfortunately for squint correction, the older the child grows, the greater his interest in near work becomes.

Without question it is desirable to develop binocular vision at the earliest age possible. However, we are of the opinion that bifoveal fusion produces the most satisfying correction for the patient, although a longer period of time is required. If a child of an acceptable age is given orthoptic training, in order to eliminate suppression, before surgical alignment of the eyes is undertaken, the subsequent development of single binocular reading is easier and quicker. The majority of concentrated orthoptic exercises are of necessity given at the cortical level, as it is hardly possible to begin intensive training during the years of reflex development.

It is necessary to consider the psychological, physical and chronological age of the child as well as the type of squint, when training for single binocular vision is attempted. Usually, training for near is not begun until the child is five to six years of age. However, as in fusional development, there is no definite age at which to begin near training except that which Julia Lancaster so well describes in her book as "the age of readiness." Preparatory training of an individual nature can begin when the patient is first seen and is beneficial at whatever the age may be.

Patients can go from one level of training to another more easily and without realizing it if they are not given tasks beyond their maximum ability or under their minimum efforts. At the beginning of an exercise period, a review of the work already accomplished often aids in advanced training. Individual adaptations of techniques are most advantageous.

The development of single binocular reading is in a forward, backward and forward manner, as a new card on the bar separator accomplished one day may not be accomplished on the next day because of accommodative variations. A return to a simpler card may be necessary before trying more advanced work again. The cards that come with the bar separator were designed with this purpose in mind for beginners in binocular practice for near, as well as for preschool children. The degree and type of squint determines the kind of exercise that can be used on the bar separator. If the deviation is not too large, an alternator with strong suppression can be taught an appreciation of diplopia, usually without too much effort (figs. 1, 2 and 3).

Should diplopia be difficult to obtain at first on the bar separator, there are other procedures that can be helpful. Each

FIG. 1—Convergence insufficiency 22△ Xt′, 22△ Xt. Right eye preferred.

FIG. 2—Left eye fixating.

orthoptic technician has her own ingenious methods of eliciting diplopia. To mention a few, Elizabeth Stark uses red and green glasses; Louisa Wells Kramer teaches voluntary squinting to the patient; Jean Robinson has devised a nose bar; Elizabeth

FIG. 3—Diplopia exercise bar separator.

Jackson has a set of finger cap targets which she finds useful; Angela Swenson and Anita Stelzer have demonstrated the use of a red clip over the Swenson temporal occluder; Aletha Tibbs has success with her hand bar; Alice McPhail has small hand targets; and Mary Kramer suggests several methods in her book. Quite often, I simply use my hand or the patient's in a vertical position against the nose between the eyes (fig. 4).

Directing the patient where to find the images tends to expedite and facilitate the treatment. However, as important as diplopia is in our treatment of squint, it is not desirable unless followed by bifoveal

FIG. 4—Hand position for diplopia exercises. Alternating fixation 24△ Et′, 20△ Et.

fusion. The bar separator requires this function for the achievement of single binocular reading. With a less exacting device, fusion can be accomplished sooner, but at the same time, foveal suppression may be permitted.

In certain cases, I have found the bar separator an aid in developing fusion on the major amblyoscope in that suppression was broken by requiring bifoveal perception and the patient became alert to diplopia.

A boy, first seen at eight years of age, a nonaccommodative alternator, had refused first-grade and second-grade binocular vision on the major amblyoscope with all the gymnastics I knew. His suppression area was small but deep. The angle of deviation was 24△ Et' and 20△ Et, which allowed use of the bar separator without prisms for diplopia exercises. After the first two visits, during which the bar separator was used, diplopia was spontaneous on the bar separator, and simultaneous foveal perception and fusional development increased rapidly on the major amblyoscope. A first-grade foveal-macular target was followed on the major amblyoscope to eliminate the ease of suppression with second-grade targets.

With prism and cover test and card 2 on the bar separator, the angle of deviation in a nonaccommodative squint is usually within a few prism diopters of the findings for near on the major amblyoscope. Exercises on the bar separator are not advised until after an orthoptic examination on the major amblyoscope has been made. The one condition which the majority of our cases have in common is suppression. Suppression, or the lack of it, is one of the strongest indications of the progress of our cases. The bar separator can be used to combat suppression as well as for fixation practice, dissociation and vergence exercises. Each of the bar separator cards can be used at various times to detect suppression, depending upon the type of squint and the area of suppression. By using a small light, the technician may watch the corneal reflections and determine the approximate angle of deviation. Home exercises for diplopia are a helpful adjunct to office training.

The bar separator was designed to eliminate artificial means of correction as nearly as possible and yet to give the necessary help required for bifoveal near training (fig. 5). There is a curved head rest, separator, bar, material rack, clip to hold material at fixed distance, and hand or table rest. Objectively, the eyes can be observed at all times, and the cover test can be used when necessary (fig. 6). Subjectively,

FIG. 5—Walraven bar separator.

the patient is comfortable. His hands can be free for hand-eye exercises (fig. 7). Material is securely held, and a variety of materials relating to normal application of the eyes can be used.

Each of the seven cards that come with the bar separator has a specific purpose but all can be used interchangeably (fig. 8). As orthoptists, we recognize that training of an individual nature is required, but certain conditions occur so frequently that a discussion of general technique is in order.

The first card is used to begin fixation practice, the first step toward single binocular reading; it is followed by the other cards as progress is made toward the formation of a line for reading, as seen in card 7. Cards 1 through 6 can be used for diplopia or fusion exercises. Cards 2, 4, 5, and 6 are used to let the beginner learn bifoveal perception on the center fixation target, fusion, dissociation and

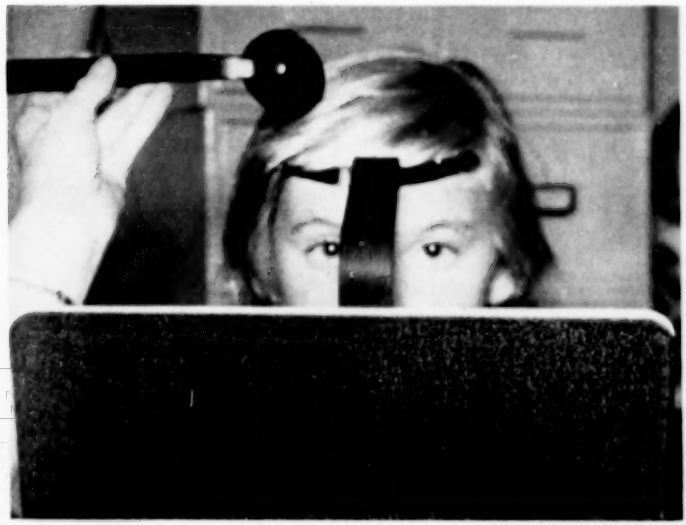

FIG. 6—The cover-uncover method is used with a patient in the beginning to elicit diplopia. Each eye is directed toward the fixation target.

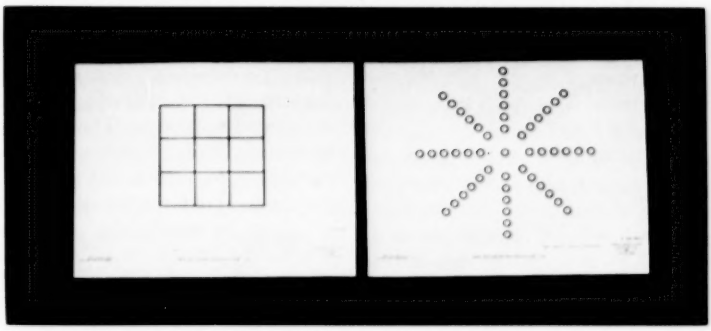

FIG. 7—Bar separator drawing pads for hand-eye coordination.

vergence exercises; that is, for increasing diverging and converging power with hand prisms. Also, these cards are used for the first attempt in making side movements from center fixation to the left figure, then back to center, and to the right, then back to center, without losing bifoveal fusion.

The time element may vary considerably at any one level of development and with the individual case. There may be only an interval of weeks between cards 1 and 2 and over a year between cards 1 and 7, or only a month between cards 1 and 7. For example: you may have an intelligent six-year-old patient with nonaccommodative squint of the convergence excess type and with normal visual acuity, normal retinal correspondence, no refractive correction, only a slight innervational factor, and casual binocular vision for distance. Binocular vision is not a new experience to this patient, and fusion can be held at zero position on the major amblyoscope. Off the major amblyoscope, an

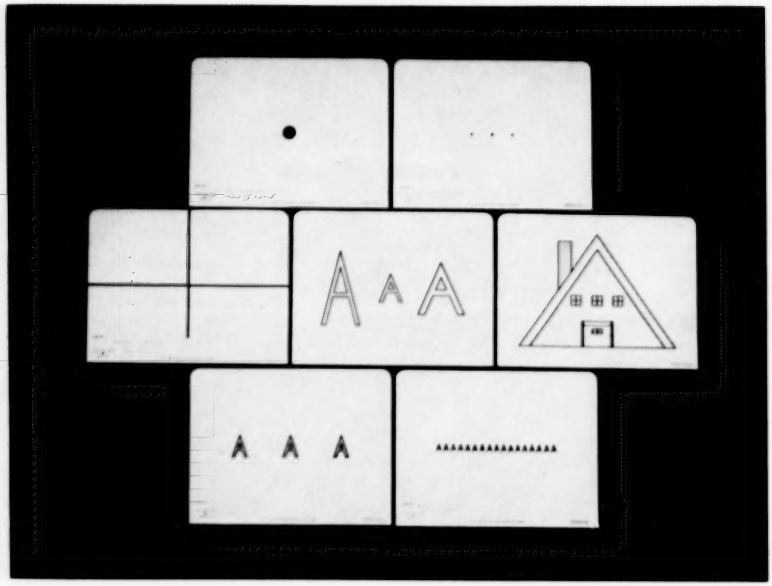

FIG. 8—Bar separator cards. 1, upper left; 2, upper right; 3, 4 and 5, center reading from left to right; 6, lower left; 7, lower right.

esotropia is present for near. On the bar separator, fixation is spontaneous, either eye fixating card 1 and center dot on card 2. Diplopia is quickly appreciated on center dot of card 2, and fusion with card 2 follows. Mastery of card 3 indicates absence of cyclophoria and vertical deviation. The patient is then ready for dissociation exercises on cards 4, 5, and 6. At the end of a month, work can begin on card 7. Exercises with hand prisms on center dot of card 2, along with bifoveal fusion side movements with card 2, can be given simultaneously with dissociation practice in this type of case. Also, home clearing practice is beneficial, continuing use of cards 4, 5, and 6 at first, and later adding card 7 for more detailed work. Sunglasses are worn with one lens out and the other lens before the fixating eye, covered during near work only, as binocular vision is present for distance.

The accomplishment of card 7 may require several months, as that card presents a more complicated situation. The size of the letters is reduced, which requires more accommodative effort. The increase in line formation requires greater control of the muscles in looking to the extreme ends of the line. Hand-eye coordination can be improved by having the patient point to the middle line of each "A" while maintaining bifoveal fusion, which is an exacting accomplishment. At first, the beginner does well to maintain bifoveal fusion and clear the center letter in the line. The progress in clearing and increasing side movements is a slower process. Also, card 7 is used as is card 2, to practice movements from left to right of the center letter, and then from right to left and back to the center letter. Gradually, as bifoveal fusion is maintained, letters are added on each side of the center letter until the line is completed in that manner. This can be accomplished while blurring is still present. Printed reading material is necessary for more advanced detailed work.

As another example: a patient with a 60△ nonaccommodative squint of the divergence insufficiency type may require over a year between the use of cards 1 and 7. Training may consist of unilateral fixation practice on the bar separator with cards 1, 2, 4, 5, and 6, and major amblyoscope work for fusional development. A surgical operation leaves a residual deviation of 20△, which allows diplopia exercises on the bar separator with cards 1 and 2, but the fusional range is insufficient for bifoveal fusion with card 2. Diplopia can be practiced with cards 1 through 6, but is confusing with card 7. A second surgical procedure and major amblyoscope training is necessary before bifoveal fusion is obtained with card 2. The patient is then ready for dissociation practice, that is, the development of normal relationship between convergence and binocular accommodation with cards 4, 5, 6, and 7, along with vergence development with card 2. Occlusion of the fixating eye is prescribed for both distance and near until after the second surgical operation, and then for near only until single binocular vision has developed. Home exercises for antisuppression with cards 1 through 6 are beneficial after the first operation, and dissociation practice with cards 1 through 7 after the second operation.

Home clearing is a very important part of training during dissociation exercises. A certain amount of time is necessary for binocular accommodation to develop, and the more often this new experience is presented, the easier the task becomes. However, the age factor has to be considered from two viewpoints. Usually, there is a variation in accommodation at different ages. There may be a decrease in hyperopia and accommodative power as the child grows older, unless the refractive error is not of a type which decreases. In accommodative cases, we prefer to work without glasses unless there is an astigmatic error above a .50 cylinder and the visual acuity is less than 20/30 in each eye without glasses. The patient is not asked to use bifocal lenses; rather, the materials used are of an adequate size. Smaller figures can be used later to meet the child's increased accommodative ability, which may vary from time to time. The material can be changed daily if necessary. A clip is used over the fixating eye for near work until single binocular reading is accomplished.

It is my opinion that teaching blurring before fusion is present at the angle of deviation on the major amblyoscope and before diplopia is achieved with card 2 will only further complicate the case.

Printed reading material is confusing and too difficult for beginners. Later, more advanced training is possible and desirable. I have designed a series of graded word practice sheets, based on the Lebensohn near vision chart, to help control the training and to lead the individual from one reading level to another. The practice sheets (fig. 9) present sentences constructed so that various thought combinations can be put together without the patient's memorizing the sentences.

In learning single binocular reading, the patient with squint meets a psychological problem, as single binocular reading has not become a visual pattern. The patient can become frustrated in trying to do what is yet unlearned. Simple instructions and praise given for not alternating on the bar can help to avoid this problem. Bar reading practice time at home can be used advantageously to parents and child in bringing a personal contact, time for which is sometimes difficult to find in a busy schedule. Dissociation practice can be painless if results are not expected and work not requested beyond the individual's developmental level for that time.

The development of fusion on the major amblyoscope usually requires less time than training for single binocular reading. The amount of time and money required for training for single binocular reading

FIG. 9—Bar separator reading page.

is comparable to that expended for music, dancing lessons, or physical treatments of a prolonged nature. Most often, single binocular reading can be learned before the child is of the age for extracurricular studies. Sufficient time must be allowed to accomplish this by a voluntary process. Single binocular reading requires the most refined adjustment and coordination of the sensory and motor apparatus that the patient with squint has been called upon to make. When single binocular reading is accomplished, it is the first time that the patient has used his eyes for near in a normal way. It is the culmination of orthoptic training for the individual. By this attainment, the patient can be assured that all the orthoptic corrective measures have been justified.

We have found that bifoveal fusion required for single binocular reading, when firmly established, continues to improve and ensures a normal use of the eyes. In rechecking cases of three years' duration and longer in which single binocular reading had been attained (figs. 10, 11, 12, 13, and 14), we found that the results warrant the additional time, effort and expense

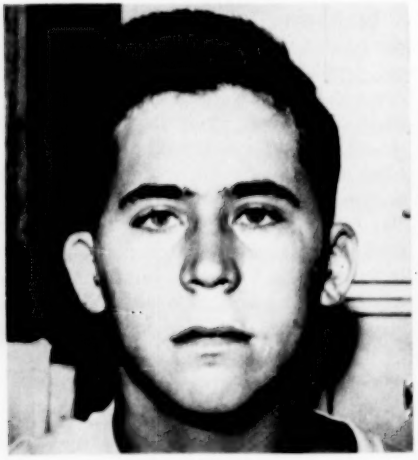

FIG. 10—Single binocular reading for over five years. Present age: 16 years. Visual acuity: SC 20/15 each eye. Deviation before correction: 45△ Et', 20△ Et with an alternating sursumduction. One surgical operation at age of 5 years. Preoperative and postoperative orthoptic training.

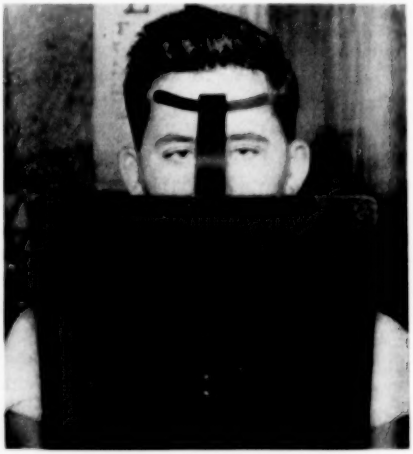

FIG. 11—Eyes in reading position.

FIG. 12—Reading print comparable to 20/40 Lebensohn near vision chart. Number of words on lines exceeds the usual reading material necessary in daily life.

FIG. 13—Single binocular reading for over three years. Deviation before correction: 46△ Et', 42△ Et with an alternating sursumduction. One surgical operation. First refractive correction at 2 years of age: R. —650 vision 2/20; L. —650 vision light fixation. Last refractive correction at 10 years of age: R. —800 —1.25 axis 15 vision 20/30; L. —800 —1.00 axis 165 vision 20/30. Preoperative and post-operative orthoptic training.

FIG. 14—Side view of figure 13.

involved. The gratification of the patients more than repays the orthoptist and the ophthalmologist for their persistent efforts.

ACCOMMODATIVE ESOTROPIA: CAUSE AND TREATMENT

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ACCOMMODATIVE esotropia is a particular type of convergent strabismus that is associated with the effort of accommodation. The excessive convergence of accommodative esotropia is attributable to the interesting fact that accommodation and convergence are associated activities. The particular pattern by which accommodation and convergence are associated is peculiar to each individual. Each association pattern of accommodation and convergence is either inborn or becomes established during the first several months of age. This established pattern of accommodation and convergence association remains relatively unchanged during the developmental period of the child. Ideally, the association of accommodation and convergence would be such as to afford simultaneously clear vision and binocular vision regardless of the nearness to or the distance from the eyes that the object attracting the visual regard be located. The frequency of accommodative esotropia making its appearance at the age at which children first satisfy their desire for clear vision is testimony that the accommodation-convergence association pattern is not ideal in all children. The accommodation-convergence association pattern, all too frequently, yields clear vision at the expense of binocular vision. Accommodative esotropia often becomes the price a child is forced to pay for clear vision.

ETIOLOGY

There are two primary factors that cause accommodative esotropia to appear at the age the child first strives for clear vision. These factors may occur singly or in combination. The first is hypermetropia, and the latter is an abnormal accommodation-convergence association pattern. There is one secondary factor that must be recognized as an aid, at least, to the primary factors that cause accommodative esotropia. This secondary factor is referred to as the basic esophoria.

HYPERMETROPIA

Hypermetropia, with increasing severity proportional to its amount, represents hardship to the child in his demands for clear binocular vision. The hypermetropic child, in applying the established accommodation-convergence association pattern to clear the vision, risks the possibility of excessive convergence. Accommodative esotropia, therefore, may develop as a complication of the hypermetropic child's experiencing clear vision.

ABNORMAL ACCOMMODATION-CONVERGENCE ASSOCIATION

The established association pattern of accommodation and convergence, if normal, will provide simultaneously clear binocular vision for all points of fixation whether near to or distant from the eyes. This implies that the exact amounts of accommodation and convergence invariably and automatically issue forth in the proper combination necessary for clear binocular vision regardless of whether the child be fixating a star an infinite distance away or the head of a pin three inches away.

However, such an ideal or normal accommodation-convergence association pattern is not possessed by all children. One common abnormality of the established

Read at the meeting of the Eastern Section of the American Association of Orthoptic Technicians, March 15, 1954, Washington, D.C., and at the meeting of the Southern Section of the American Association of Orthoptic Technicians, April 26, 1954, Florence, S.C.

association of accommodation and convergence is an excessive amount of convergence (more than will automatically permit binocular vision) being associated with each diopter of accommodation. Proportional to the severity of this defect is the magnitude of hardship confronting the child desiring to enjoy simultaneously clear and binocular vision while accommodating. In the absence of hypermetropia, a child afflicted with this defect may experience clear binocular vision while fixating a distant object, but esotropia while seeing a near object clearly. The hypermetrope may be esotropic if accommodating while fixating either a distant or near object; however, the esotropia at near will be greater than at distance fixation. Consequently, accommodative esotropia may occur in the presence or absence of hypermetropia if a child afflicted with an abnormal accommodation-convergence association pattern accommodates to attain clear vision.

BASIC ESOPHORIA

The basic alignment exists when the eyes are fixating a distant object (for example, 20 feet away) in the unaccommodated state. Accommodative esotropia cannot occur in the absence of accommodation. Consequently, a basic alignment of eyes in any position other than parallelism cannot in itself be considered as an isolated cause of accommodative esotropia. However, a basic convergent malalignment acts as an additional handicap to the child accommodating and attempting to maintain binocular vision if either hypermetropia and/or an abnormal accommodation-convergence association pattern is present. Therefore, basic esophoria can be considered an indirect or secondary cause of accommodative esotropia. Hypermetropia and an abnormal accommodation-convergence association are the direct or primary causes.

AMPLITUDE OF RELATIVE FUSIONAL DIVERGENCE

If the child were dependent solely upon the accommodation-convergence association pattern to yield simultaneously clear and binocular vision, such an association pattern would be required to be quite precise, to say the least. Furthermore, there could be no allowance for a refractive error or any basic malalignment of the eyes. Since such exactness in the make-up of human beings runs counter to the overall plan of nature, it is only to be expected that some system should exist which compensates for the lack of perfect ocular alignment induced by either the dioptric power of the eyes or the neurologic pattern by which accommodation and convergence are associated, or for an already existent basic malalignment of the eyes. The fusion mechanism is that system which corrects for the errors of alignment, regardless of the cause, in order that binocular vision be attained. Since accommodative esotropia is excessive convergence that appears for one reason or another, the particular aspect of the fusion mechanism that counters the excessive convergence is of great importance to this subject. This aspect of the fusion mechanism is fusional divergence.

The fusional divergence which can be measured is referred to as the amplitude of fusional divergence. Yet, the important feature of the amplitude of fusional divergence, is not the amount of divergence capable of being attained while disregarding accommodation, but rather that amount of divergence possible relative to a fixed amount of accommodation. Determining the amount of divergence a child possesses while fixating a light is quite different from determining the divergence available while fixating and identifying small symbols graded in size to the patient's best visual acuity. The accommodation is uncontrolled while fixating the light, whereas it is controlled while identifying small symbols. The former is a measurement of the amplitude of fusional divergence; the latter is a measurement of the amplitude of relative fusional divergence, relative to a fixed

amount of accommodation. Measuring the relative fusional divergence amplitude is all-important in accommodative esotropia.

Regardless of the enormity of the excessive convergence concomitant to the correct amount of accommodation needed to clear the vision, and regardless of the amount of basic esophoria that is present, the excessive convergence can be overcome if the relative fusional divergence amplitude exceeds it. Therefore, clear and binocular vision are simultaneously possible in the presence of hypermetropia, an abnormal accommodation-convergence association pattern, or a basic esophoria. However, if the excessive convergence that develops while the eyes are accommodating is greater than the amplitude of relative fusional divergence, accommodative esotropia is manifested.

METHODS OF MEASUREMENT

The first primary cause of accommodative esotropia, hypermetropia, is measured by a cycloplegic refraction.

The second primary cause of accommodative esotropia, an abnormal accommodation-convergence association pattern, is determined by comparing the prism and alternate cover measurements obtained while fixating at twenty feet and at thirteen inches. The accommodation must be controlled while the prism and alternate cover measurements are done. This is accomplished by demanding the child to identify small symbols that are used for fixation objects while he is wearing a full ametropic correction. Prism and alternate cover measurements at twenty feet and at thirteen inches that are identical, as determined by the above technique, indicate that the accommodation and convergence association pattern is normal. Greater convergence at thirteen inches than at twenty feet is the type of abnormal accommodation-convergence association pattern that causes accommodative esotropia.

The third factor that indirectly, at least, contributes to the development of accommodative esotropia is a basic esophoria. The basic esophoria is that esophoria measured by prism and alternate cover while the eyes are fixating at twenty feet in the unaccommodated state. Absence of accommodation is assured by demanding the patient to identify small fixation symbols while wearing the ametropic correction.

The relative fusional divergence amplitude, that factor which attempts to compensate for the above three causes of accommodative esotropia, can be measured either directly or indirectly. The orthoptic technician can easily and readily determine the amplitude of relative fusional divergence with a haploscope. The accommodation is controlled by having the child wear ametropic correction and read or identify foveal target symbols as the arms of the machine are moved in the manner that require the eyes to diverge if binocular vision is to be maintained. It is impractical to attempt direct measurement of the amplitude of relative fusional divergence with the aid of prisms. Prisms distort the small fixation symbols to the point that they cannot be identified and this difficulty precludes proper control of the accommodation.

An indirect method of estimating the amplitude of relative divergence can be easily done with the use of lenses, and the estimate is sufficiently accurate to be of real clinical significance. The accommodation is controlled by having the child wear ametropic correction while he identifies small symbols at a designated working distance. I prefer thirteen inches as the working distance, which means that three diopters of accommodation are required for clear vision. If binocular vision is possible at the same time that the small symbols are identified, then minus lenses are superimposed before the ametropic correction. This increases the demand for accommodation, which in turn also increases the convergence that is called forth since accommodation and convergence are associated phenomena. In order to negate the increased

convergence associated with the increased accommodation, the relative fusional divergence is applied. Consequently, binocular vision is maintained at the thirteen-inch working distance despite the increase in accommodation. The superimposed minus lens power is stepped up to the point that the accommodation demanded for clear vision becomes so great that its concomitant convergence eventually exceeds the amplitude of relative fusional divergence. At this point accommodation esotropia may be manifested. A prism and alternate cover measurement performed while the patient is identifying small symbols with the maximal superimposed minus lenses that permit binocular vision is an indirect determination of the amplitude of relative fusonal divergence.

If accommodative esotropia is present in the identification of small symbols at thirteen inches through the ametropic correction but binocular vision is present at twenty feet, the patient has such an abnormal accommodation-convergence association pattern that even the three diopters of accommodation required to obtain clear vision at thirteen inches is associated with such an excessive convergence that the amplitude of relative fusional divergence is exceeded. Therefore, to indirectly determine the amplitude of relative fusional divergence in this type of accommodative esotropia by using lenses, the accommodation required at thirteen inches must be lessened to the point that the concomitant excessive convergence is reduced to where it first fits within the amplitude of fusional divergence. This is accomplished by superimposing increasing plus lens power before the ametropic correction until binocular vision becomes possible while identifying the small symbols. A prism and cover measurement performed while such a patient identifies small symbols with the minimal superimposed plus lenses that permit binocular vision is an indirect determination of the amplitude of relative fusional divergence.

TREATMENT OF ACCOMMODATIVE ESOTROPIA

Since the phenomenon of accommodation must be exercised prior to the manifestation of accommodative esotropia, it is logical to consider that curbing the accommodation demands by the use of spectacles is proper therapy. No child, regardless of age, is too young to receive the aid of spectacles promptly at the time accommodative esotropia makes its appearance. To neglect accommodative esotropia in the young child by not prescribing spectacles soon after its onset is to court the danger of complications developing. These complications are as follows: (1) an increase in the convergent strabismus which becomes constant so that spectacles which put the accommodation at rest no longer restore binocular vision, (2) amblyopia in the non-fixating eye, (3) suppression of the retinal area in the non-fixating eye that corresponds with the fovea of the fixating eye, (4) abnormal retinal correspondence, and (5) fixation disparity.

I shall not discuss the therapy of the complications of accommodative strabismus. What I do wish to discuss is the treatment of the primary and secondary factors which cause accommodative esotropia and the one factor which compensates for accommodative esotropia.

The hypermetropia is treated by prescribing the ametropic correction.

The abnormal accommodation-convergence association pattern may cause accommodative esotropia to be present while the patient is experiencing clear vision at near, despite ametropic correction being worn, yet no esotropia is present while the patient is seeing clearly at distance. An added bifocal segment is necessary to provide clear and binocular vision at near. The prescription for the lower segments should not automatically be +3.00 adds, but more ideally, the minimum plus power that will provide binocular and clear vision at near. The segments should be large (38 mm. round), and their top should be placed

high in order for the child to find it difficult not to use them. The factor of "prism jump" is of no significance to these tiny immature accommodative esotropes.

The factor of basic esophoria usually requires no treatment; however, if the esophoria is quite large, surgery is the therapy of choice. Caution should be exercised not to correct surgically any more of the esotropia than that which is basic. This means that the portion of the esotropia that is due to the accommodative element should not be surgically corrected.

The factor that compensates for the causes of accommodative esotropia is the relative fusional divergence. A large amplitude of relative fusional divergence can compensate for a surprisingly great hypermetropia, quite an abnormal association of accommodation convergence, or a sizeable basic esophoria, the potential accommodative esotropia being masked as long as the child is willing to apply the relative fusional divergence. A lesser amplitude cannot cope with the factor or factors that cause accommodative esotropia, the strabismus being apparent on all occasions when the vision is cleared.

The amplitude of relative fusional divergence is variable. In some children it will spontaneously enlarge with increasing age, thereby permitting control of the accommodative esotropia with progressively weaker lenses. In the properly motivated child, the orthoptic technician can usually effect a dramatic increase in the amplitude of relative fusional divergence. This is the entity which the technician is manipulating when carrying out "dissociation exercises" for accommodative esotropia.

Because the accommodative esotrope is too young at the onset of the strabismus for orthoptic training designed to increase the amplitude of relative fusional divergence, spectacles are almost always the first therapy that the child receives. Surgical intervention is rarely required for the basic esophoria. Orthoptics should be considered when the child is of sufficient age to permit easy comprehension of the "exercises" and when he manifests a real desire to gain improvement.

At the time that the amplitude of relative fusional divergence improves either spontaneously or by orthoptics, the spectacle lens power should be accordingly weakened even to the point of doing away with the spectacles entirely, if such is possible. This is mandatory if the improvement in the amplitude of relative fusional divergence is to be put to everyday seeing use. Seldom does asthenopia ensue with the application of a large amount of relative fusional divergence for intense and lengthy visual activities.

Some discretion must be used in the selection of patients for orthoptic training. The extreme hypermetropic, astigmatic, or anisometropic accommodative esotrope has little chance of doing away with glasses. Consequently, orthoptic attempts to increase the amplitude of relative fusional divergence are an unjustifiable hardship for this type of patient.

Orthoptics improves the accommodative esotropia only by increasing the amplitude of the relative fusional divergence. Orthoptics does not change the hypermetropia, the degree of abnormality of the accommodation-convergence association pattern, or the basic esophoria.

SUMMARY

The following three factors, singly or in combination, cause accommodative esotropia while the eyes are accommodating to see clearly: (1) excessive hypermetropia, (2) an abnormal amount of convergence associated with each unit of accommodation, and (3) a basic esophoria.

A compensatory factor, the relative fusional divergence, attempts to overcome the accommodative esotropia and achieve binocular vision and clear vision simultaneous-

ly. The three causative factors and the one compensatory factor are all measureable clinically.

The treatment of accommodative esotropia is twofold: (1) early alleviation of the particular cause or causes and (2) later enhancement of the compensatory factor. At the time of onset, glasses are indicated for hypermetropia, bifocal segments for an abnormal accommodation-convergence association pattern; surgery is seldom necessary for the basic esophoria. When the child is older, orthoptic training is useful in increasing the amplitude of relative fusional divergence.

CONSIDERATIONS IN TREATMENT OF ANOMALOUS RETINAL CORRESPONDENCE

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EVERY orthoptist whose task it is to restore to her patients, in so far as she is able, comfortable single binocular vision, daily encounters many obstacles. One of the greatest and most challenging obstacles is anomalous retinal correspondence. This paper is a brief correlation of some of the factors of which we are all aware and to which we must give attention in determining the training procedure and the prognosis for our patient.

As you know, retinal elements which have common visual directions are corresponding retinal elements, the foveas necessarily being the corresponding points par excellence. This is the basis for the fusion of the monocular images which fall upon the fovea of each eye, into one binocular image, and is known as normal correspondence. However, when the fovea of one retina and an eccentric element in the other retina acquire a common visual direction, there is a new sensorial relationship developed which is termed anomalous retinal correspondence (ARC). In heterotropia, anomalous retinal correspondence frequently develops; it represents a sensorial adaptation to the squinting position of the eyes. Anomalous retinal correspondence is not always a clear-cut entity as far as accuracy in measurement is concerned. It is clear-cut only in the sense that the fusion angle does not correspond to the angle of the deviation. While it is possible for fusion to occur in anomalous retinal correspondence at the subjective angle, this anomalous fusion has been found impractical for good single binocular vision. The patient is seldom able to appreciate perfect fusion; he has no stereopsis, and he is usually unable to appreciate fusional amplitude. Anomalous retinal correspondence is often a variable factor, and may occur in association with normal retinal correspondence (NRC).

Conscientious use by the technician of all available diagnostic measures for determining the state of anomalous correspondence, and under which conditions normal, anomalous, or both states of correspondence are present, is important in deciding the treatment to be followed and making a prognosis.

It is not the purpose of this paper to discuss the diagnostic tests except to mention the following: (1) Bielschowsky afterimage test, (2) major amblyoscope diagnosis, (3) the red-glass diplopia test (as described by Burian), (4) the Lancaster red-green test, and (5) phi phenomenon, or the observation of subjective movement.

If the results of the tests consistently reveal anomalous retinal correspondence, and changes in conditions do not influence them, the anomalous relationship is judged to be firmly established. If, however, the responses to the tests are variable and reveal different modes of localization for different tests and under varying conditions of testing, the anomalous correspondence is judged to be less firmly established and, depending upon the depth of the relationship and the adaptability of the patient, therefore more amenable to orthoptic training. Since very few patients are received for training at the onset of their squint, the depth of anomalous correspondence found is extremely variable. It ranges from a deeply rooted anomalous

Read at the meeting of the Eastern Section of the American Association of Orthoptic Technicians, March 15, 1954, Washington, D. C.

retinal correspondence to anomalous correspondence which is only superficially established. In a few cases anomalous and normal correspondence can be elicited at the same time. Patients with this last condition are able to appreciate monocular diplopia or binocular triplopia, in which instances they are localizing simultaneously in two visual directions with the deviated eye. This occurrence takes place only when there is rivalry between the normal and the anomalous correspondence; it has long been recognized in postoperative cases in which a paradoxical diplopia was elicited.

The acquisition of an anomalous retinal correspondence is due to an adaptation of the sensory apparatus of the eyes to an abnormal situation. This is believed to be a physiologic and not a psychologic process. The individual has made an adaptation which, for him, we may call normal, since it is a sensorial adjustment which affords him the most comfort and the least confusion in the abnormal situation in which he finds himself. Therefore, when we begin corrective treatment we are, in a sense, introducing a psychologic factor. We are temporarily creating a more difficult and necessarily a more confusing situation for which the patient must make another adjustment. I believe that the psychologic factor becomes an important consideration during the training period.

No two people react alike to the same situation. One of the first considerations for the technician is to establish a good rapport with her patient. Training procedure is often arduous, and it requires concentration and good cooperation. The technician must learn to expect different reactions from different patients, and she must be able to judge the best time to introduce a new or more difficult step in training procedure. When the transition from anomalous to normal retinal correspondence is easily and smoothly made, there is little difficulty. However, in most cases this is not true. Major and minor stumbling blocks are forever arising. For example, in many cases a stubborn central suppression is found; in a small angle esotropia it may be difficult to determine whether anomalous correspondence is truly present; and when physiological diplopia is first taught, varying degrees of confusion exist and must be dealt with.

I do not feel that it is fair either to the patient or to the technician to discontinue training after six to twelve orthoptic sessions if even a little progress has been indicated. In some children progress is slow, and many times patience and perseverance accomplish a great deal. Practicing technicians have repeatedly experienced the successful response to treatment in cases in which training was continued for a longer period. It seems obvious to expect a greater length of time to elapse for the patient to adjust to normal correspondence since the anomalous relationship apparently does not arise spontaneously and cannot be expected to disappear spontaneously until the normal relationship becomes the habit of preference. On the other hand, it is not fair to continue treatment indefinitely when no progress can be noted; there are some cases which do not respond.

The course of treatment to be followed in each individual case should be determined with consideration of the following factors:

1. Angle of squint
2. Depth of stability of the anomalous correspondence
3. Equality of vision
4. Refractive error
5. Age of the patient
6. Comfortable use of the patient's binocular apparatus
7. Cosmetic appearance of the patient

Angle of Squint

Generally speaking, in cases in which the angle of squint is high, (we consider any measurement greater than 40△ to 50△ in convergent strabismus and greater than 30△ in divergent strabismus to be high)

and amblyopia exists, when the vision in the deviating eye has improved to 20/50 or better, surgery is immediately considered, followed by occlusion if necessary and active orthoptic training. When the deviation is small (we consider any measurement of 10△ in both convergent and divergent strabismus to be small) the treatment of choice is occlusion with active orthoptic training and surgery is considered early only when a vertical deviation of over 10△ is involved. In the event of failure of orthoptic training, surgery may be considered later for cosmetic effect or if it appears necessary for better alignment when normal correspondence is apparent on the major amblyoscope. In all other cases, other factors being equal, occlusion and active orthoptic training is carried on for a period of six to twelve weeks, or until normal correspondence with some fusional reserve has been established on the major amblyoscope, before surgical intervention.

Depth or Stability of Anomalous Correspondence

In cases in which diagnostic measures reveal a firmly established anomalous retinal correspondence and training elicits little or no response, surgery is considered early, followed by training if the doctor so advises.

Equality of Vision and Refractive Error

These factors require little discussion. Equal vision in both eyes is of course the first objective, with optimum refractive correction for any accommodative element or astigmatism. When anisometropia or a high degree of astigmatism exists, prognosis has been found to be unfavorable.

Age of the Patient

This factor also needs little discussion. It is not always so much the age of the patient which is important, as it is his ability to understand and cooperate. Generally speaking, very few children under the age of four have a long enough attention span to carry out any difficult orthoptic procedure. From an orthoptic viewpoint, the best results in treating anomalous correspondence are in children of 6 years or more. Theoretically, the earlier the problem of ARC is attacked, the better are the chances of correcting it. Therefore, our doctors feel that in the very young patient early surgery is advisable.

Comfortable Use of the Patient's Binocular Apparatus; Cosmetic Appearance of the Patient

These factors become significant in cases of small angle esotropia, and especially significant from the orthoptist's viewpoint in postoperative cases, when a small residual deviation remains. In patients with good cosmetic results and with a limited degree of fusion appreciated with adequate comfort, it is possible that no more can be accomplished.

Before a decision can be made as to the method of treatment, it is necessary to assure oneself of the nature of the binocular pattern. In considering these factors, it is important to recognize and to discriminate between what is known as fixation disparity and anomalous retinal correspondence. The importance lies here; if a patient who in reality has an anomalous retinal correspondence is treated for a fixation disparity, that is, on the basis of normal correspondence, training can only establish more firmly the anomalous relationship. That this distinction is not only important but difficult to determine is testified to by disagreement among various authorities as to the interpretation of the binocular response in small angle esotropia. In view of the variability of the fusion factor and the wide range of adaptability for compensation, fixation disparity compatible with single binocular vision is entirely plausible. However, since it is agreed that anomalous correspondence is an adaptive process on the part of the individual to restore a binocular pattern, an anomalous sensorial relationship is surely possible in small angle esotropia.

Jampolsky reported in his article on retinal correspondence in small degree strabismus (Archives of Ophthalmology, Jan. 1951) that anomalous correspondence, usually of the unharmonious type, occurred in about 90 per cent of the cases that he studied with the angle of strabismus less than 15△. He stated that most of these cases were monocular in type, with slight amblyopia of the deviating eye, a high incidence of anomalous peripheral fusion, and an area of foveal or macular suppression in the deviating eye. Experience gained in selecting and studying, for this paper, six cases of residual esotropia, each with an esotropia of less than 15△, tended to confirm Jampolsky's findings. We found four cases which we felt exhibited characteristic anomalous retinal correspondence. A typical case follows:

R.S. A boy, aged 6 years. First seen in November 1949. History revealed a constant right esotropia since the age of 3.5 to 4 years. He had worn glasses since the age of 4, with partial correction of his deviation.
Refraction and visual acuity as follows:

R.E. — 1.75 — 0.25, x85; 20/40
L.E. — 1.75 — 0.25, x90; 20/20

Prism and cover test. With correction, distance: 16 △ esotropia with 2 △ left hyperphoria, near: 18 △ esotropia with 2 △ left hyperphoria. Without correction, distance: 20 △ esotropia with 2 △ left hyperphoria; near: 24 △ esotropia with 2 △ left hyperphoria. Afterimage and prism diplopia tests revealed anomalous correspondence with slight displacement of images to crossed diplopia.

On the major amblyoscope. Objective angle at 18 △ esotropia, 2 △ left hyperphoria with crossed diplopia. No superimposition of images at first, but after 8 visits incomplete fusion appreciated with little help, and frequent central suppression R.E. occurred. Subjective angle at 6 △ esotropia, 1 △ left hyperphoria. Simultaneous macular perception and fusion were appreciated with central suppression R.E.

After 8 visits, the subjective angle had changed to 10 △ esotropia. Vision R.E. had improved to 20/30. Total occlusion and orthoptic training were continued, and in June 1950 surgery was done, with good cosmetic result. Postoperative prism measurement revealed a residual right esotropia of 6 △ for distance, 8 △ for near, with 1 △ left hyperphoria. Subjective angle was at 2 △ base out. With postoperative training, the patient was able to appreciate first and second grade fusion with 5 to 6 mm. targets at the objective angle of squint, and low fusional amplitude was attained. No stereopsis was appreciated, and central suppression R.E. persisted. With 1 to 2 mm. targets, slight crossed diplopia was appreciated. Complete foveal fusion was never attained. Afterimage test, prism diplopia and parallax tests revealed anomalous correspondence with very slight displacement of images to crossed diplopia. Active orthoptic training and occlusion were continued until June 1951. Off the instrument, the patient appreciated shaky fusion for distance and near with red glass, and partial fusion with septum devices, but physiological diplopia could not be properly appreciated, and Worth four-dot invariably revealed slight crossed diplopia. Training was discontinued at this time for a period of 3 months, then resumed again without occlusion. The second session of training revealed no further improvement and was discontinued in April 1952. Since that time, the patient has been observed at 6 to 8 month intervals. No appreciable change has taken place. Cosmetic appearance is good; the parents are happy, and the child's schoolwork has shown improvement.

In those cases where cosmetic effect is good, and where an anomalous adaptation has been made, which affords the patient a binocular pattern allowing him comfort, we feel that there is very little to be gained in attempting to establish normal retinal correspondence by prolonged orthoptic training, especially since we are very apt to end in failure of the desired goal.

CONSIDERATIONS IN TECHNIQUES OF TRAINING

Orthoptic treatment of anomalous retinal correspondence is necessarily limited at first to occlusion and major amblyoscope methods. Of the various procedures used, we have selected three major amblyoscope techniques which we feel are the most effective.

1. *Flashing technique*, used in conjunction with alternate and binocular foveal fixation.

In this procedure, the arms of the major amblyoscope are set at the objective angle of squint, and vertical adjustment is made. A 3 mm. box with a foveal fixation mark is introduced to the deviating eye. A 1 mm.

ball, with a dot in the center, to the opposite eye. The light to the left eye is turned off and the patient is directed to fix the dot in the center of the box. Then the light to the left eye is turned on, the light to the right eye is turned off, and the patient is directed to fix the ball. Both lights are then turned on and the patient is asked if he can see both images. Crossed diplopia is seen, and the patient is asked to note the separation of the ball from the box. The process is repeated successively; first the right eye, then the left eye, then both eyes. Each time that both images are presented, the patient is asked to note whether the ball moves any closer to the box. In some instances, momentary superimposition will take place; each time that it does so, both lights are left on until the images separate or until one image is suppressed. Then the procedure is repeated. When binocular fixation appears to be steady, the arms of the instrument are moved to 0 or to a divergent position, and the patient is asked to consciously alternate fixation and, at the same time, to appreciate homonymous diplopia.

We have found that by using this method, foveal fixation is improved and the Mayou and Walraven techniques can more easily be utilized. While using this procedure, an increase or variability of the angle is occasionally noted, probably due to the increased effort of accommodation and convergence. This factor does not appear to hinder the development of a better foveal fixation, especially if rest periods are allowed during the procedure.

2. *The Mayou Technique,* as described by Sheila Mayou in the British Orthoptic Journal, 1947.

This technique makes use of small SMP targets, allowing vertical deviations to be readily detected, and one can transfer the actual operation of the instrument to the patient, thus stimulating the patient's interest and cooperation, and his desire to succeed.

In this method six SMP slides are used. There are two foveal fixation targets and four rectangle slides. The smallest fixation slide is used as the fixation target for one eye, and the rectangle slides, which decrease in size, are used as the moving targets which can be moved by the patient. In the largest rectangle are 3 small boxes, any of which will just enclose the fixing slide. With the right eye fixing, and the largest rectangle placed over the left eye, the objective angle is measured and vertical adjustment made. The orthoptist then sets the left arm of the amblyoscope so that the 3 boxes appear just to the left of the fixation target. The patient is encouraged to maintain fixation with his right eye while, with the left hand, he moves the 3 small boxes slowly to the right of the ball and then back again to the left. When the patient first begins, the area of movement is large. He is encouraged to reduce this by limiting the movement to allowing the boxes just to pass to the right and back to the left of the ball, and no more. Movement generally begins in the area of the subjective angle, but as the range of movement reduces, it narrows down to the objective angle where first grade fusion is established. Care must be taken that the patient does not alternate and that both images are seen equally clearly. In a few cases, the patient learns to position any one of the 3 boxes around the fixation object. However, in many cases central suppression persists; then the remaining 3 rectangle slides are used in succession, beginning with the largest, until the patient can enclose the fixation target in each rectangle at his objective angle. When the range of movement remains in the area of the subjective angle, the patient is encouraged to maintain fixation of the right eye, while the orthoptist moves the opposite arm back and forth across the objective angle in the manner of macular massage. When the patient is able to enclose the ball in the center of the 3 boxes at his objective

angle with either eye fixing, first grade fusion and normal retinal correspondence have been established.

This method is especially useful in overcoming central suppression and has the advantage of being simple enough to be used successfully on younger patients.

3. *The Walraven Technique*

This technique stimulates the use of monocular diplopia. In this method it is necessary to use foveal targets and to have established a fairly good foveal fixation. Anomalous correspondence must not be firmly established, it must be variable enough to allow stimulation of normal correspondence.

The patient is first taught to fixate alternately with the arms of the major amblyoscope at a divergent position beyond his subjective angle. When steady alternate fixation has been established, the patient is encouraged to maintain fixation with his deviating eye, but he must be seeing both images, while the arms of the instrument are slowly brought toward the subjective angle. At the subjective angle, foveal fixation of the deviating eye becomes difficult and stimulation by flashing may be needed to assure foveal fixation. At this time the patient appreciates monocular diplopia. The true image is dim; it is localized toward the temporal side, and is easily suppressed. The patient is encouraged to concentrate on the dim image while the arms of the instrument are slowly brought toward the objective angle, thus invading the suppression area. Much stimulation to maintain fixation of the deviating eye is often necessary at first. Slowly the true image becomes brighter until first grade fusion can be appreciated at the objective angle and the false image eventually disappears.

This technique brings very satisfying results for those patients on whom it can be successfully carried out. In my experience the use of this method requires good cooperation and concentration on the part of the patient, and it is therefore applicable only to cases selected on that basis and to cases in which the anomalous relationship is easily disturbed.

In conjunction with each of these methods, total occlusion of the nondeviating eye or alternate occlusion in cases of alternating strabismus is used. When normal correspondence has been established on the instrument and the patient is ready to begin off-instrument training, temporal occlusion, as described by Angela Swenson, is used, and the patient is seen at more frequent intervals when posible, for more close observation of the retinal response. We have used temporal occlusion in the transition period from total occlusion to no occlusion, and we feel that it is helpful in preventing the patient from reverting to his anomalous habit in casual seeing.

Physiological diplopia is taught at the moment when the patient is able to appreciate fusion with normal correspondence, and is incorporated into home training.

Following surgery, the patient is seen in the orthoptic clinic on the same day he is dismissed from the hospital, when possible, before the bandage has been allowed to remain off both eyes. Postoperative position is noted, and the Worth four-dot test is done. If a residual deviation is apparent and the Worth four-dot test reveals crossed diplopia, the dominant eye is kept covered. The patient is seen daily, and training is resumed when the light sensitiveness has decreased sufficiently to allow observation with the major amblyoscope. Occlusion is used temporally or not at all according to the progress of the patient.

SUMMARY

Seven factors of relative importance in determining the treatment in cases of anomalous retinal correspondence have been briefly discussed, with emphasis on the recognition of the binocular pattern employed in cases of small angle esotropia. A case study is included. These cases do

present a problem, since if we are to evaluate them on the basis of the standard measurement of cure, they must be classified as at least partial failures. However, we are more and more accepting the fact that normal retinal correspondence is not necessarily synonymous with single binocular vision. In cases with good cosmetic alignment and in which a comfortable binocular pattern is being used or has been developed, our orthoptic measures at the present time have often not produced a cure. This is by no means intended to imply that anomalous retinal correspondence is not amenable to orthoptic training. Excellent results in these patients are obtained by accurate diagnosis, intelligent training and surgery at the proper time.

Three major amblyoscope techniques, which have proved to be effective in establishing the desired normal retinal correspondence, and pointers concerning follow-up care which we have used successfully, have been presented.

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CYCLOVERTICAL MOTOR ANOMALIES

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I. An Objective Method of Analysis

CYCLOVERTICAL motor anomalies occur frequently. Although their evaluation is difficult, the use of a standard, routine method of examination and analysis is helpful. The routine method described in this paper centers around a diagram that provides a graphic record of the ocular movements. The movements are indicated directly on the diagram, and its subsequent study facilitates the diagnosis and evaluation of the anomaly present.

ACTION OF MUSCLES IN SINGLE EYE

The diagram may be considered as an abstract photograph of the movements seen when the patient faces the examiner. Figure 1 is the diagram for the normal movements of the patient's right eye. The solid lines show the movements of the right eye in the patient's right field of gaze, and the open lines show the movements of the right eye in the patient's left field of gaze. When the right eye is abducted into the right field, the principal elevator is the right superior rectus, and the principal depressor is the right inferior rectus. When the right eye is adducted into the left field, shown by the open lines, the principal elevator is the right inferior oblique and the principal depressor is the right superior oblique.

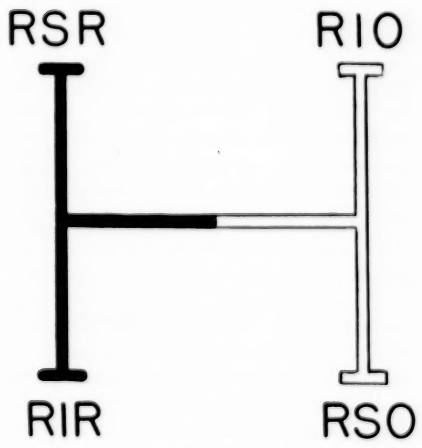

FIG. 1—Ductions of right eye. Black line represents right field; white line represents left field.

In figure 2 the movements of the left eye are diagrammed as they appear when the patient is facing the examiner. The right field of gaze is indicated by the solid lines, and the left field by the open lines.

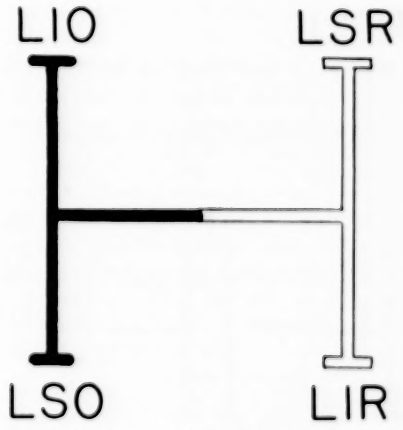

FIG. 2—Ductions of left eye. Black line represents right field; white line represents left field.

Part I was read at the meeting of the Eastern Section of the American Association of Orthoptic Technicians, March 15, 1954, Washington, D. C.
Part II was read at the meeting of the Southern Section of the American Association of Orthoptic Technicians, April 26, 1954, Florence, South Carolina.

When the left eye is adducted into the right field of gaze, along the solid lines, the chief elevator is the left inferior oblique and the chief depressor is the left superior oblique. When the left eye is abducted into the left field of gaze along the open line, the left superior rectus is the principal elevator and the left inferior rectus is the chief depressor.

TEAMS OF MUSCLES

The mutual interrelation of the vertical muscles in the two eyes is easier to understand when we think of the vertical muscles as constituting two teams. One team controls the vertical position of the eyes in the right field. It is called the "right field vertical team," and is shown on the solid lines in figure 3. This team consists of the

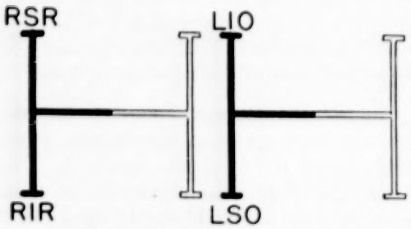

FIG. 3—Right Field Vertical Team. Two muscles in the right eye and two muscles in the left eye have the chief vertical action in the right field of gaze.

muscles that have the major vertical action in the right field of gaze. In the right eye it comprises the superior and inferior recti, and in the left eye the superior and inferior obliques.

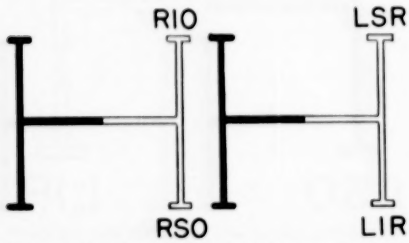

FIG. 4—Left Field Vertical Team. The diagram indicates the four muscles having the chief vertical action in the left field of gaze.

The other team controls the vertical position of the eyes in the left field. It is called the "left field vertical team," and is shown on the open lines in figure 4. This team consists of the superior and inferior recti of the left eye and the superior and inferior obliques of the right eye.

PRELIMINARY EXAMINATION

Before studying the deviation in the cardinal directions, certain preliminary examinations should be made. A detailed history of the deviation is important, and a complete ophthalmologic study should be done in every case. If the condition was acquired and nontraumatic in origin, the examiner should be certain to consider serious systemic or intracranial disease.

The examination of the muscle balance begins with tests to determine the presence and amount of any vertical and horizontal deviation in the primary position, both while the patient fixates an object at 20 feet and again while fixating an object at 13 inches. Any difference noted in the vertical deviation when fixation is shifted from far to near may be useful in differentiating a weakness of an oblique from that of a rectus. In a weakness of a rectus, the deviation is often greater at distance. In contrast, a weakness of either of the obliques often gives a greater deviation for near.

These measurements should be made not only with but also without the correction for any existing refractive error. A small fixation target requiring accommodation should be used when testing fixation at near. Otherwise, deviations associated with the innervation required for accommodation may not be revealed.

The eye habitually used for fixation should be determined and recorded by placing a cross mark on the diagram of the proper eye. If the patient alternates fixation, a cross is placed on the diagram for each eye. The relative size of the crosses may be varied, the larger cross indicating the eye preferred for fixation.

After these preliminary examinations, tests are made to determine the specific muscles involved in the imbalance. In these studies, efforts are directed toward finding the weak muscle.

FIRST TEST: EXTENT OF DUCTIONS

The extent of monocular rotation of the right eye is tested in the four diagnostic quadrants: right and up, right and down, left and up, left and down. While the ductions of the right eye are being tested, the left eye is covered so it cannot see the target. Normal ductions of the right eye are indicated by placing a short horizontal line at the upper and lower ends of the vertical lines in the diagram for the right eye (figs. 3 and 4).

Ductions are then tested for the left eye, while the right eye is covered. Normal ductions of the left eye are indicated by short horizontal lines at the upper and lower ends of the vertical lines in the diagram for the left eye (figs. 3 and 4).

Any limitation of duction in either eye can be indicated on the diagram by solidly blocking off part of the corresponding vertical line. The line blocked off will indicate the eye and the field in which the limitation was observed. Various degrees of limitation can be indicated by blocking out a greater or lesser amount of the vertical line. This will graphically represent the relative amount of weakened duction. For example, figure 5 is a diagram of the ductions of a patient with a left hypertropia. The solid black mark in the upper right field of the right eye shows that a deficiency of duction was present in this diagnostic quadrant. The horizontal lines indicate normal ductions in the other quadrants. The diagram shows that the defect in duction was due to a weakness of the right superior rectus—the muscle producing elevation of the right eye in the right field of gaze.

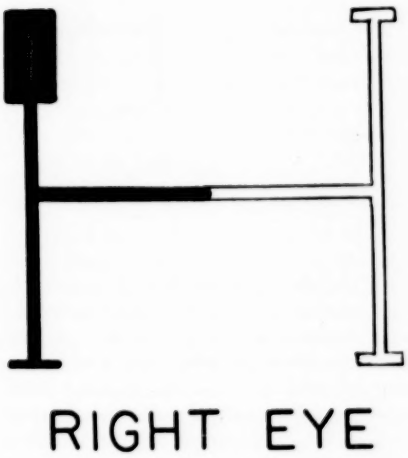

FIG. 5—Limitation of duction. The solid block is used to show a limitation of duction. In this case a limitation in the right upper quadrant indicates a weakness of the right superior rectus.

When there is a limitation in duction it is not difficult to discover the weak muscle. However, in most cases with hypertropia, no defective monocular movements can be discovered in any of the cardinal fields. It has been shown that a large percentage of the power of an ocular muscle must be destroyed before a defect in duction will result. However, with a paresis, a binocular imbalance will be present even though no defect in monocular movement may be detected. Therefore, in those cases with normal monocular rotations, a second test must be used.

SECOND TEST: SCREEN COMITANCE TEST

When the ductions in each eye are normal, a test of the binocular balance must be made, for considerable binocular imbalance may be present even when monocular ductions are normal. To test the binocular balance, the screen comitance test is used. This test is performed by partially covering one eye so it cannot view the target, although the examiner can watch its movements behind the screen.

Let us consider a second patient with a left hypertropia who showed normal ductions in each eye. With the right eye fix-

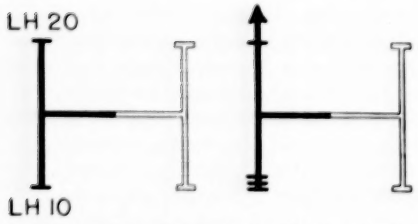

FIG. 6—Binocular imbalance in left hypertropia—right eye fixating. Fixation with right eye shows overshoot of left eye in right upper quadrant and lag in right lower quadrant. Measurements of deviation obtained with right eye fixating are recorded over diagram of right eye.

ating, the target was carried into the four diagnostic quadrants, and any lag or overshoot in the covered left eye was noted. When the right eye was fixating in the right upper quadrant, an overshoot was observed in the covered left eye. This was recorded by a corresponding arrow extending above the horizontal line in the right upper quadrant of the diagram for the left eye (fig. 6). A lag in the left eye was also noted in the right lower quadrant. This is recorded by small horizontal lines in the right lower quadrant of the diagram for the left eye (fig. 6).

After all four quadrants had been tested with the right eye fixating, the screen comitance test was repeated with the left eye fixating. This time the cover was placed over the right eye so that it could not fixate the target. The left eye was then carried into each of the diagnostic quadrants, while the examiner looked for any lag or overshoot in the covered right eye. A lag was observed in the right eye in the right upper quadrant. This was recorded by short horizontal lines on the diagram for the right eye in the right upper quadrant (fig. 7). An overshoot of the right eye was also observed in the right lower quadrant. This was recorded by an arrow extending below the horizontal line in the right lower quadrant of the diagram for the right eye (fig. 7).

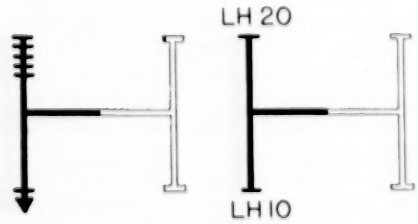

FIG. 7—Binocular imbalance in left hypertropia—left eye fixating. Fixation with left eye shows a lag of right eye in right upper quadrant and overshoot in right lower quadrant. Measurements obtained with left eye fixating are recorded over diagram of left eye.

It will be noted that the results of the screen comitance test with the right eye fixating were recorded in figure 6, while the results of the same test with the left eye fixating were recorded in figure 7. Although this separate recording of the results was introduced to clarify the explanation of the diagrams, in actual practice the recording of observations when the right eye is fixating are combined in a single diagram with the results observed when the left eye is fixating (fig. 8).

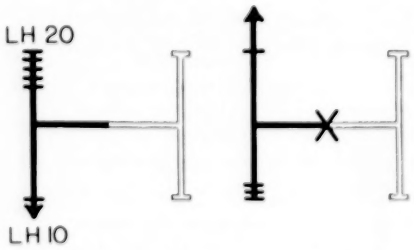

FIG. 8—Composite diagram of vertical imbalance. The cross mark on the diagram for the left eye indicates that the left eye was habitually used for fixation.

When the right eye fixated, it was carried in the right upper quadrant to the full extent of its normal duction, as indicated by the uppermost horizontal line in that position (fig 8). At the same time, the covered left eye overshot to an extent indicated by the top of the corresponding arrow. When the right eye fixated, it was carried in the right lower quadrant to the full extent of its normal duction, as indi-

cated by the horizontal line in that position. At the same time, the covered left eye lagged to an extent indicated by the uppermost horizontal line shown in the right lower quadrant of the diagram for the left eye.

It is also shown in figure 8 that when the left eye fixated, it too was carried to the full extent of its ductions. Thus the left eye was carried to the position indicated by the horizontal line in the right upper quadrant of the diagram of the left eye. At the same time, the covered right eye lagged to an extent indicated by the lowermost horizontal line in the right upper quadrant of the diagram for the right eye. Likewise, when the left eye fixated in the right lower quadrant, it was carried to the full extent of its ductions as indicated by the lowermost horizontal line in that position. At the same time, the covered right eye overshot to an extent indicated by the arrow shown in the right lower quadrant of the diagram for the right eye.

Analysis of the diagram shown in figure 8 indicates a primary weakness of the right superior rectus.

THIRD TEST: PRISM AND COVER TEST

After the deviations indicated by the screen comitance test have been graphically recorded, they are accurately measured with the screen and prism technique. For these measurements it is better to use loose prisms, with horizontal and vertical combinations so that both components of the deviation can be neutralized simultaneously. The face of the prism should be perpendicular to the line of fixation. For the measurements to have significance, the positions of the four diagnostic quadrants should be standard and constant. If the position of the target varies during the course of an examination or from one examination to the next, the measurements of the deviation in the diagnostic quadrants will be not only useless but, in addition, misleading. The use of the deviometer is the most satisfactory method of obtaining constant and standard positions of the target in the diagnostic quadrants. This instrument has the fixation light on the end of an arm that can be automatically rotated into fixed, constant diagnostic positions.

In making the measurements, fixation is first maintained with the right eye. This is accomplished by placing the correcting prisms in front of the right eye and the cover in front of the left eye at the beginning of each observation. Observations are made only on movement of the left eye when the cover is shifted from the left eye to the right eye. Movement that occurs in the right eye when the cover is returned to the left eye is ignored. The prism which stops the movement of the left eye is selected. In this way, the right eye is constantly used for fixation during the test, eliminating the confusion that might arise if measurements were made when fixation was allowed to shift from one eye to the other.

The measurements in prism diopters, found in the patient we have been considering, are recorded in figure 8. The measurements of the deviation in the right upper and right lower quadrants are shown in the diagram over the corresponding positions for the right eye. Any measurements placed over the diagram for the right eye indicate that they were obtained while the right eye was fixating. In this patient the measurement of the deviation in the right upper quadrant showed 20 prism diopters of left hypertropia. The measurement in the right lower quadrant showed only 10 prism diopters of left hypertropia. The greater deviation in the right upper quadrant indicated a weakness of the right superior rectus.

In the measurements made with the right eye fixating, the amount of deviation in the right upper quadrant was greater than the deviation in the right lower quadrant. This difference indicated the weak muscle, namely, the right superior rectus. However, in some patients a difference in

the deviation in the diagnostic quadrants is not found. Let us consider a third patient with a left hypertropia who has no defect in duction, as did the first patient, and no difference in the imbalance in the diagnostic quadrants with the right eye fixating, as did the second patient. To establish the diagnosis of the weak muscle in this patient we must repeat the prism and cover measurements with the left eye fixating.

When we measure the deviation with the left eye fixating, the prisms are placed in front of the left eye and the cover in front of the right eye. Now only the movements of the right eye are watched. The prisms are changed until the movement of the right eye is abolished. The measurements made when the left eye is fixating are placed on the diagram over the figure representing the left eye.

Figure 9 shows the results obtained in testing our third patient. The measurements obtained while the right eye was fixating are recorded over the diagram for the right eye, and those obtained when the left eye was fixating are placed over the diagram for the left eye. In this third patient the vertical deviation was greater when the left eye was fixating. If there is a difference in the amount of the deviation when fixation is shifted, the paretic muscle is in the eye that is fixating when the larger deviation is present. Therefore, in the case of our third patient, the weak muscle was in the left eye and was the left superior oblique.

What explanation is there for the increase in deviation that occurs when the paretic eye fixates? According to Hering's Law, the innervation for any movement of the eyes flows equally to each eye and is determined by the fixating eye. When the eye on the side of the weakened muscle fixates, increased innervation is required. This increased innervation is sent to the normal yoke muscle, causing it to overact and thereby increasing the deviation.

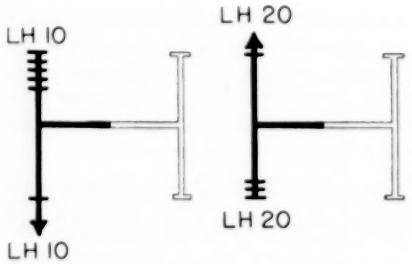

FIG. 9—Increase in left hypertropia when deviation was measured with left eye fixating.

FOURTH TEST:

HEAD POSITION AND HEAD TILTING TEST

Occasionally the amount of vertical deviation is equal in the diagnostic positions regardless of which eye is used for fixation. Figure 10 shows the diagram for such a case. The cross mark on the diagram for the right eye indicates that the right eye was habitually used for fixation. Ductions were normal since the diagram shows no solid blocking out of any vertical line, as was seen in the patient represented in figure 5. The left hypertropia was present only in the right field of gaze as shown on the black lines.

On the screen comitance test, when the right eye was fixating and carried into the right upper quadrant to the uppermost horizontal black line, the covered left eye overshot to the top of the black arrow shown on the diagram for the left eye. When the fixating right eye was carried to the limits of depression, indicated by the black horizontal line in the right lower quadrant of the right eye, the covered left eye lagged to the uppermost horizontal line in the right lower quadrant of the left eye. The crosshatching indicates an insufficiency of the left superior oblique.

When fixation was shifted and the fixating left eye was carried in the right upper field to the normal limit of elevation indicated by the horizontal line, the covered right eye lagged, as indicated by the crosshatching for the right eye in the right upper quadrant. This represents insuf-

ficient action of the right superior rectus. When the fixating left eye was carried in the right lower field to the normal limits of depression indicated by the lowermost horizontal line, the covered right eye overshot to the end of the black arrow in the right lower quadrant. The equality in size of the crosshatching and the arrows suggests that the deviation was the same in both the upper and lower quadrants of the right field of gaze, regardless of which eye was used for fixation.

The measurements when the right eye was fixating are shown over the figure for the right eye. In both the upper and lower quadrants, 20 prism diopters of left hypertropia were obtained. The figures over the diagram for the left eye indicate the results of the prism and cover test when the left eye was fixating. Again the left hypertropia measured 20 prism diopters in both the upper and lower quadrants.

Therefore, in the fourth case, the vertical deviation was the same in the upper and lower quadrants of the right field, regardless of the fixating eye (fig. 10). From these tests alone, it was not possible to determine whether the right superior rectus or the left superior oblique was primarily involved. Additional tests were required to determine the muscle with the principal insufficiency.

The fourth test of the diagnostic plan is a study of the position of the head. The best way to observe the position of the head is to ask the patient to walk across the room, touch the muscle light and return. Often, the patient with a head tilt has been told over and over again by his relatives to keep his head straight. When he goes to the doctor, he is on his guard and will keep his head straight, obscuring the underlying abnormal position while he is under observation in the examining chair. Only when a specific task is given to him is his guard relaxed, allowing the head to assume its characteristic position.

In some patients, the head assumes a postural attitude characteristic of the paretic muscle. With a muscle palsy, the head is turned in the direction of action of the weak muscle, causing the weak muscle to relax. This decreases the deviation and facilitates fusion. In palsies of the cyclovertical muscles, the head may be turned into a position which results from rotation around the three principal axes, i.e., to the right or left around the vertical axis, up or down around the horizontal axis, or tilted to the left or right shoulder on an anterior-posterior axis. For example, in the case of a left superior oblique palsy, the head is rotated on the three axes as follows: it is tilted to the right shoulder on the anterior-posterior axis, turned to the left on the vertical axis, and the chin is depressed on the horizontal axis. The tilt to the shoulder is the chief factor in an oblique palsy, since the main action of the obliques is tortion in the primary position.

The head posture characteristic of a given palsy is easy to remember. It is the position of the head which would result by contraction of the paretic muscle if the paretic ocular muscle were attached to the head in the same position it occupies on the eye. Thus in the case of the left superior oblique, we can imagine the muscle as attached to the left superior-posterior part of the head on the temporal side. This is the same relative position it occupies on the eye. Contraction of a muscle with this insertion would tilt the head to the right shoulder, turn the head to the left, and depress the chin.

In the case of a weakness of the right superior rectus, the muscle can be imagined as attached to the right superior-anterior part of the head slightly on the temporal side. This is the relative attachment of the right superior rectus in the right eye. Contraction of this hypothetical muscle would elevate the chin, turn the head to the left and slightly tilt the head to the left shoulder. The resulting position is the characteristic head position found in a palsy of the right superior rectus.

The characteristic head tilt can be determined in the same fashion for a weakness of any other ocular muscle. Its recognition is sometimes useful in discovering the paretic muscle. However, the characteristic head position does not develop in every case of palsy. Moreover, in some, it may be lost subsequently if suppression occurs. Rarely, the head may be in a position exactly opposite to that characteristic of the underlying palsy. When this occurs, the double images will be as widely separated as possible, facilitating suppression.

The forced head tilting test is useful. In this test the vertical deviation is measured first with the head placed on the right shoulder, and then again with the head placed on the left shoulder. In a paresis of a superior oblique, the vertical deviation will increase when the head is placed on the shoulder of the same side as the higher eye.

FIG. 11—Head Tilting Test. When the head is tilted to the left shoulder, the left superior oblique and left superior rectus contract. If the left superior oblique is weak, the unopposed elevating action of the left superior rectus will cause an increase in the left hypertropia.

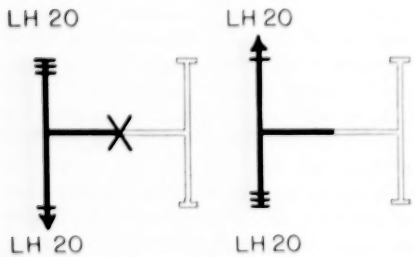

FIG. 10—Left hypertropia shows no change in diagnostic quadrants regardless of fixating eye.

Figure 10 shows that in our fourth patient, the left eye was higher. Therefore, if the vertical deviation increases when the head is placed on the left shoulder, the paretic muscle is the left superior oblique. In contrast, if the paretic muscle were the right superior rectus, the deviation would remain the same, or perhaps decrease, when the head was placed on the left shoulder.

The increase in the vertical deviation that occurs in a superior oblique paresis when the head is placed on the shoulder on the same side as the higher eye is explained by the vestibular ocular reflexes. When the head is tilted, the vertical meridians of the eyes tend to remain perpendicular to the ground. Thus, when the head is tilted to the left shoulder, the right eye normally extorts. At the same time, the left eye intorts by contraction of the left superior rectus and the left superior oblique (fig. 11). When these muscles are

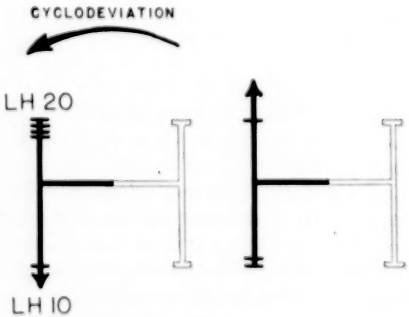

FIG. 12—Diagram of cyclodeviation resulting from a weakness of right superior rectus.

normal in power, the elevating action of the left superior rectus is neutralized by the depressing action of the left superior oblique, and vertical alignment of the eyes is maintained. However, if the left superior oblique is weak, its counterbalancing depression is absent, and the left eye will be raised by the unopposed elevating action of the normal left superior rectus.

The cyclodeviation resulting from a weakness of one of the ocular muscles can be easily predicted by the use of the diagram. Figure 12 shows the diagram for the ocular movements of a patient with a left hypertropia. The deviation is greatest in the right upper quadrant, indicating a weakness of the right superior rectus. Since this muscle is an intorter, its weakness will cause the 12 o'clock position of the right eye to turn outward as the right eye turns on its anterior-posterior axis. The resulting cyclodeviation is shown by the curved arrow in the diagram. The cyclodeviation resulting from any paresis can always be predicted by drawing a curved line on the diagram toward the weak muscle.

Figure 13 illustrates the cyclodeviation resulting from a paresis of the left superior oblique, when the left hypertropia is greatest in the right lower quadrant. A curved arrow drawn toward the diagram for the weak muscle, as in figure 13, shows the resulting cyclodeviation.

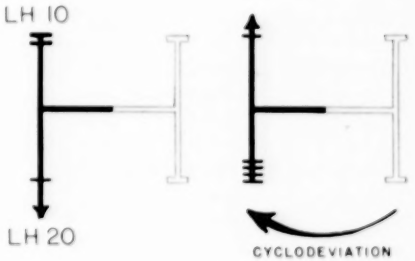

FIG. 13—Diagram of cyclodeviation resulting from a weakness of left superior oblique.

Tilting of the head, which might occur from the cyclodeviation, will be in the direction opposite to the cyclodeviation. Thus, in the patient with the left superior oblique weakness (shown in figure 13), the upper pole of the left eye is turned outward as the eye turns on its anterior-posterior axis. The head will be tilted toward the right shoulder, in the direction opposite to this cyclodeviation.

II. Subjective Tests and Characteristic Clinical Syndromes

Some cases with cyclovertical deviations will present contradictory evidence when tested by objective methods. In others, objective tests will not reveal the primary muscle weakness. Supplementary subjective tests are required in these cases to establish the diagnosis.

Even after the application of all available objective and subjective tests, the diagnosis of a specific weakness will not be possible in some of the cases encountered. Fortunately, however, these latter cases can be classified into characteristic clinical syndromes.

SUBJECTIVE TESTS

For the analysis of cyclovertical motor anomalies, objective methods of examination are usually preferable because they are universally applicable to all cases regardless of the age or cooperation of the patient. They can be used in cases of long duration as well as of recent vertical imbalances. They can be used regardless of the presence of abnormal retinal correspondence, or suppression. In addition, they produce more complete dissociation of the eyes than subjective tests.

However, subjective tests have two advantages. They are more useful in meas-

uring small deviations, especially in those patients with phorias. In addition, subjective methods are more suitable than objective ones for measuring the tortional component of the deviation. If objective tests do not reveal the identity of the weak muscle, subjective tests should be used. The subjective tests are of two types: first, the diplopia tests, and second, the projection tests.

The simplest one of the diplopia tests is measuring the diplopia field. With a red glass before the right eye and a green one before the left eye, the patient looks at a white light. With his right eye he will see a red light, and with his left eye a green one. The relative position of the red and green lights is noted. The diplopia can be measured on a tangent screen or by superimposing the red and green lights with correcting prisms. The diplopia is measured in the primary position for distance and near fixation, then in the diagnostic quadrants, and finally for primary and secondary deviation. The deviometer is a convenient fixation light, for it standardizes the conditions of the test. The diplopia is greatest in the field of action of the paretic muscle. The more peripheral image belongs to the eye containing the paretic muscle.

For measuring the tortional component of cyclodeviations, a streak source of light is needed. However, occasionally patients are confused when they see both vertical and tortional deviations together. They may not be able to determine the diagnostic quadrant in which the separation of the images is greatest, for the greatest tortional displacement occurs in a diagnostic quadrant different from the one where the greatest vertical displacement is found. However, in some cases a study of the cyclodeviation will be the only clue to the correct diagnosis.

Instead of using red and green goggles, the diplopia test can be performed with the multiple Maddox rod. When a white and a red Maddox rod are used, the test is excellent for measuring cyclodeviations. It is also useful in determining primary and secondary deviation by directing the patient to shift fixation from the red line to the white one. However, measurements are difficult to make in the diagnostic positions with the Maddox rod. When combined with the cover test, the use of the Maddox rod is one of the most accurate and sensitive of all tests for measuring phorias in the primary position.

The second group of subjective tests are the projection tests. The one most used is the Lancaster red-green test. In this test, a red glass is placed over the right eye and a green glass over the left eye as in the diplopia tests. However, where there is only one white light for fixation in the diplopia tests, two lights are used in the projection tests. One is red and is seen by the right eye only. The other is green and is seen by the left eye only. The patient is told to superimpose the lights. When he apparently does so, the macula of each eye is directed straight toward its own respective image if retinal correspondence is normal. The distance separating the lights, as seen by the examiner, is a measure of the deviation. The deviation should be measured in the diagnostic positions. Again in this test, the deviation is greatest in the field of action of the paretic muscle. However, in contrast to the diplopia tests, the more peripheral image belongs to the eye without the paretic muscle. The projection test can also be used to determine the primary and secondary deviation when fixation is altered by changing the attention from the red to the green light.

A third subjective test that is sometimes helpful is charting the field of binocular vision. In this test, the fixation target is carried along the axis of a perimeter. The points at which diplopia appear are plotted on field charts. The field of binocular single vision is restricted in a characteristic fashion for specific muscle paralyses. This test is useful in recent palsies, but is of no help when suppression is present.

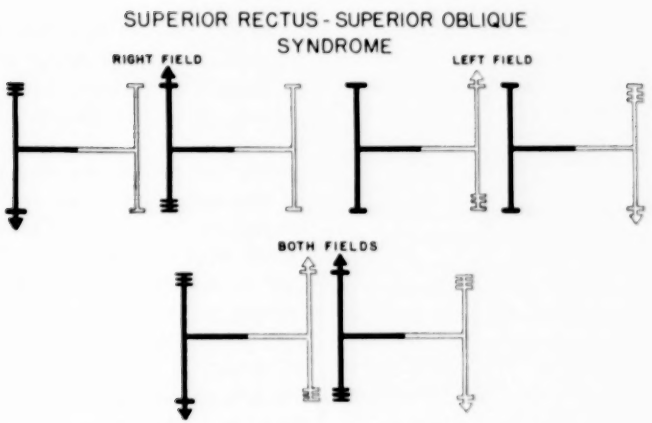

FIG. 1—Superior Rectus-Superior Oblique Syndrome. The imbalance may be present either in the right field or in the left field of gaze. Occasionally it is present in both fields.

SOME CHARACTERISTIC CLINICAL SYNDROMES

In some cases of cyclovertical deviation, the diagnosis of weakness in a single muscle cannot be established. Nevertheless, these cases can be grouped into characteristic syndromes that can be recognized clinically.

Superior Rectus-Superior Oblique Syndrome

The first of them is the superior rectus-superior oblique syndrome (fig. 1). In this syndrome, the superior rectus of one eye and the superior oblique of the opposite eye are insufficient in their action. The resulting imbalance may be present only in the right field or only in the left field of fixation. Occasionally, it is present in both right and left fields. In this syndrome the adducted eye is higher than the abducted eye. There is an associated overaction of the inferior rectus and the contralateral inferior oblique.

In this syndrome there is a striking and characteristic change in the horizontal position of the eyes when fixation is changed from the lower central field to the upper central field. In the superior rectus-superior oblique syndrome, the eyes become progressively more divergent as they are carried upward. This is particularly evident in the superior rectus-superior oblique syndrome that is present in both the right and left field of gaze. When a patient looks up, the eyes are carried upward by the contraction of the superior recti and the inferior obliques. Normally, the adducting influence of the superior recti balances the abducting influence of the inferior obliques. However, when the superior recti are weak, their adducting influence is reduced, and the unopposed abducting influence of the inferior oblique causes the eyes to become divergent when the patient looks upward.

When the patient looks down, both inferior recti and both superior obliques contract. In a superior rectus-superior oblique syndrome, the superior obliques are relatively weakened and a loss in abduction results as the eyes look down. The unopposed adducting influence of the inferior recti causes an increase in the convergence as the eyes are depressed.

Inferior Rectus-Inferior Oblique Syndrome

The second syndrome is the inferior rectus-inferior oblique syndrome (fig. 2).

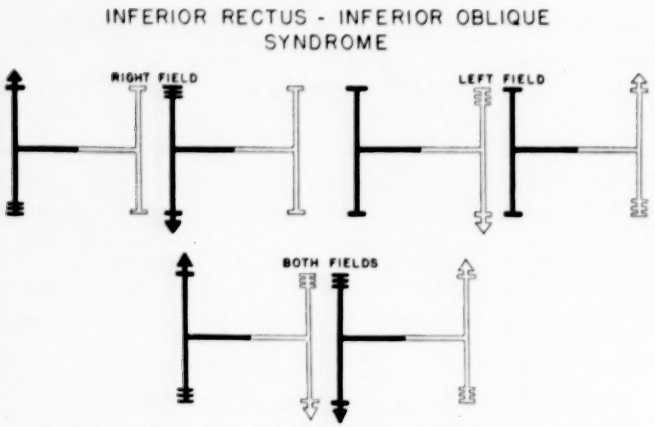

FIG. 2—Inferior Rectus-Inferior Oblique Syndrome. The imbalance may be present either in the right field or in the left field of gaze. Occasionally it is present in both fields.

In this syndrome, the inferior rectus of one eye and the inferior oblique of the opposite eye are insufficient in their action. When this occurs, the abducted eye is higher than the adducted eye. In addition, there is a relative overaction of the superior rectus and the contralateral superior oblique. The syndrome may be present only in the right field of fixation or only in the left field. Occasionally, it is present in both fields. The inferior rectus-inferior oblique syndrome is not as frequent as the superior rectus-superior oblique syndrome.

In the inferior rectus-inferior oblique syndrome, the eyes become progressively more divergent as they are depressed. This is especially noticeable when the syndrome is present in both the right and left fields of gaze. The eyes are depressed by the contraction of the inferior recti and the superior obliques. In the inferior rectus-inferior oblique syndrome, the adducting influence of the weak inferior recti is less than normal. Therefore, when the eyes look down, the unopposed abducting influence of the superior obliques causes them to diverge.

Double Elevator Syndrome

The third syndrome is called the double elevator syndrome (fig. 3). In this syndrome there is an insufficiency of the two elevating muscles, the superior rectus and

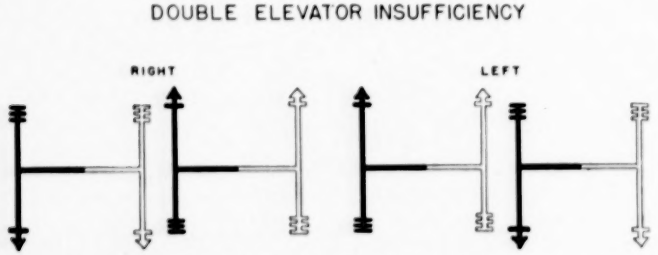

FIG. 3—Double Elevator Insufficiency. The deficient elevation may be present either in the right eye or in the left eye.

the inferior oblique of the same eye. Occasionally, the double elevator syndrome is associated with a paresis of the levator of the same eye. Rarely, the double elevator syndrome may be due to a supranuclear lesion. If this is so, Bell's reflex will be present. Then the affected eye will be elevated when the lids are voluntarily squeezed shut. At other times the double elevator syndrome may be due to firm adhesions binding the eye to the inferior portion of the orbit. In all cases of this syndrome, a forced duction test should be performed to determine whether such adhesions are present. However, in most cases of the double elevator syndrome, the insufficiency is not due to a supranuclear lesion or to peripheral adhesions. In these cases the cause must be a nuclear or infranuclear lesion.

Sometimes a case with palsy of a single superior rectus will masquerade as a double elevator palsy. These cases should be looked for carefully. A severe palsy of a superior rectus will produce a vertical deviation not only when the palsied eye is abducted but also when it is adducted. The superior rectus does not lose all its elevating action until the eye is adducted beyond 67 degrees from the primary position. After adduction of an eye 30 degrees from the primary position, about 35 percent of the power of the superior rectus is effective as elevation. Thus, even when the eye is adducted, a palsy of a superior rectus may produce a vertical deviation. The presence of this vertical deviation in adduction might be misinterpreted as a weakness of the inferior oblique of the same eye. However, the differential diagnosis can be established in most cases by comparing the amount of deviation in the diagnostic corners. A study of the cyclodeviation is also helpful in these cases. Less frequently a simulated double elevator syndrome may result from a single paresis of an inferior oblique.

EVALUATION OF THE PATIENT

After a diagnosis of the cyclovertical motor anomaly has been made, its importance to the patient must be evaluated. In many cases, the vertical deviation bothers no one but the doctor who may have discovered it accidentally in a routine examination. Before undertaking therapy for the anomaly, the physician must have clearly in mind what he specifically hopes to accomplish for the patient. In general, there are only two indications for treatment: (1) to improve binocular single vision, and (2) to achieve cosmetic improvement.

Under the first indication, the treatment is planned to re-establish or facilitate binocular single vision. This is often not possible when the deviation is congenital or has been acquired early in life. In these cases, the patient has often had the deviation for a long time before he seeks treatment. In them, binocular single vision often has never developed or has deteriorated severely with resulting suppression and, perhaps, amblyopia. For those patients who have acquired the cyclovertical deviation later in life, a restoration of binocular single vision is often most important. This is a difficult task.

Vertical fusional amplitudes are small and there is no stereopsis in a vertical direction. The lack of vertical stereopsis can be proved by holding a pencil vertically in front of the eyes while fixating an object in the distance. The pencil will be seen double because of horizontal physiological diplopia. However, when the pencil is rotated through a 90 degree angle, the two images will come closer together and finally fuse into one, all physiological diplopia having disappeared. The lack of vertical stereopsis can also be illustrated by demonstrating that bar reading is impossible with the bar held horizontally. This poor vertical fusion range and the lack of vertical stereopsis handicap the physician and orthoptist in their attempt to restore binocular single vision to those patients with cyclovertical anomalies.

Another difficulty in attempting to facilitate binocular single vision in cyclovertical anomalies is the fact that the deviation and resulting diplopia in these palsies has both a vertical and a tortional component. Both should be corrected in attempting to restore binocular single vision. Binocular single vision will not be facilitated if the vertical component is improved at the expense of making the tortional component worse. These serious difficulties should be appreciated before the restoration of binocular single vision is attempted. The duration of the deviation, the state of fusion and the tortional component of the deviation should be evaluated before formulating any plan of therapy.

Probably the majority of the operations on cyclovertical muscles are undertaken for the second indication—that of improving the cosmetic appearance of the eyes or reducing the head tilt. However, frequently in cyclovertical anomalies, the cosmetic defect is slight and operation for the correction of minor cosmetic defects is not warranted. If the ocular torticollis has been present for a long time, it may have become so habitual that it will not be corrected by operation even though perfect alignment of the visual axes may be attained.

SOME CONSIDERATIONS IN THE SELECTION OF CASES FOR ORTHOPTICS

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THE first and one of the most important steps in orthoptic treatment is the proper selection of patients. The ophthalmologist makes the diagnosis and decides upon the type of treatment for all his cases, strabismus or otherwise. Although the orthoptist does not select the cases for treatment, establishing a prognosis is one of the main functions of an orthoptic examination, and all of us as orthoptists are frequently called upon for opinions and suggestions regarding the advisability of placing patients on orthoptic treatment. We must therefore have a certain amount of diagnostic ability, for without a proper understanding of the basic types of strabismus and of the needs of each individual case we cannot direct an effective course of orthoptic treatment or make intelligent suggestions when they are requested. A close relationship between ophthalmologist and orthoptist is a necessity in the successful selection of patients.

A decision regarding whether or not a patient shall have orthoptics must be approached from two standpoints:

1. Is this case suitable ophthalmologically speaking for orthoptics?
2. What factors other than ophthalmological ones must be considered?

In thinking about the first of these questions, the diagnosis is of utmost importance. The underlying cause of the strabismus must be determined before it is possible to know whether or not the case is suitable for orthoptic training. We have learned to evaluate the relative possibilities of success in the different types of strabismus, and I believe that today there is fairly general agreement as to what it is possible and what it is not possible to accomplish with orthoptics.

In general, the heterophorias, the intermittent exotropias, and the accommodative esotropias respond most dramatically to orthoptics alone. In constant mechanical squint and in a combination of mechanical and accommodative squint, orthoptics alone cannot effect a cure. Surgery is necessary to place the eyes in a parallel position, and orthoptics is usually indispensable before and after operation in order to obtain a functional result. "The fact that orthoptic training alone is unlikely to alter the angle of mechanical squint should be brought to the attention of the child's parents. Not to do so may cause serious dissatisfaction, for in all mechanical squints surgery is indicated at the proper time."[2] When a decrease in the angle of squint takes place, it is only a secondary occurrence.

Indications for treatment of a heterophoria depend upon the presence or absence of asthenopic symptoms. If such symptoms are present, it must be determined, by a detailed examination and history, whether or not they are due to the muscle imbalance. In the treatment of a phoria, the general physical and psychological condition of the patient must be kept constantly in mind. Of the heterophorias, it is felt that the exophorias are more likely to benefit from orthoptics than the esophorias. "It is apparently much easier to stimulate an underactive convergence mechanism than it is to relax an overconvergence."[4] Patients who have symptoms indicating a convergence insufficiency for near work make up one of the most

Read at the meeting of the Southern Section of the American Association of Orthoptic Technicians, April 27, 1954, Florence, South Carolina.

satisfactory groups to treat with orthoptics; their latent deviations may be either esophoric or exophoric.

The intermittent exotropias, especially those of the divergence excess type, offer a real challenge. In most of these cases deep suppression is present and is usually very difficult to overcome; in fact, some of these persons never learn to appreciate when their eyes deviate. Since cases of divergence excess usually have normal convergence power, treatment is directed toward breaking down suppression and increasing fusional amplitudes — divergence as well as convergence. Although some of these cases respond to orthoptics alone, surgery combined with orthoptics is required to obtain constant and comfortable binocular vision for many of them.

In her book, Julia Lancaster[3] says that "refraction and correct glasses are a prerequisite to orthoptic training. Everything possible should be done to make fusion *as easy as possible* for the patient." In accommodative esotropia, correction of the refractive error is an invaluable aid in treatment but will not alone produce a cure. A complete cure can only be obtained by dissociation of convergence and accommodation through orthoptic training.

In most cases with one of the types of strabismus just mentioned, we can say that from an ophthalmological viewpoint the prognosis for a true functional cure is very good. These might be loosely classified as our "easy" cases, although I have yet to see any truly easy cases come for treatment.

Mechanical squints and combinations of mechanical and accommodative squints usually present a more guarded prognosis for functional cure than the previously mentioned types of cases. They are more frequently complicated by the presence of amblyopia, anomalous correspondence, vertical elements, paralysis and nystagmus. Fusion may be poor or nonexistent. Several examinations, or even a trial period of treatment, will usually have to be made before a prognosis can be given. A consultation between ophthalmologist and orthoptist should be held as soon as all of the facts are obtained, and an agreement reached as to the outline of treatment. At intervals thereafter reviews should be made so that should any change take place, it can be dealt with without a waste of time. There are many surprises in orthoptics due to individual determination and effort, consequently we must constantly be re-evaluating each case. If no progress is being made toward fusion after a reasonable trial period with good cooperation from the patient, this fact should be admitted readily and orthoptics discontinued. On the other hand, a good report of progress may make the ophthalmologist decide to abandon surgery or postpone it.

Just as we know in theory what is possible with orthoptics, we can also eliminate those cases which from a medical standpoint are not suitable for training: namely, amblyopia which does not respond to total occlusion, anomalous correspondence which remains intractable after intensive efforts to establish normal correspondence, anatomical abnormalities in which the rotations of the eyes make it very difficult or impossible for the patient to obtain single binocular vision (and this includes poor surgical results), absence of fusion, and high degrees of anisometropia.

When we have agreed that a case would seem amenable to orthoptic treatment, we cannot automatically place that person on active treatment. Other factors must be weighed carefully before a final decision can be reached. This brings us to the second aspect of the selection of cases; that is, factors other than ophthalmological which must be considered. This phase of the orthoptic analysis is often more difficult to assess than the medical evaluation. Here the orthoptist can frequently be of great help to the ophthalmologist in furnishing information as to the attitude of the patient and that of his parents. She sees him more frequently and becomes

in many ways more familiar with his case than does the ophthalmologist. His parents will often talk more freely to and ask more questions of the orthoptist than of the physician. Some parents are determined to go to any lengths to avoid an operation, and if the squint is one that will eventually require surgery, the orthoptist can do much toward changing this attitude and convincing the parents that the eyes will never be straightened by exercises alone. On the other hand, there are parents who are so anxious for improvement in the child's appearance and for the removal of occlusion that they want surgery immediately. Here the orthoptist can assist the busy ophthalmologist by explaining more fully to the parents the importance of preoperative orthoptics and by keeping them content to postpone surgery until the proper time.

There are some points of a psychological nature which are of much more importance to the orthoptist in her work with the patient than to the ophthalmologist in his examination. For instance, some children who will submit very cooperatively to an objective examination will make no subjective response whatever, or if they do respond, their attention span is too poor to warrant regular orthoptic sessions. Age, need of discipline, or low intelligence may be responsible for poor cooperation or lack of response. If the child's young age is responsible, it is necessary to postpone orthoptics until the child is ready. We have found it best in these cases to use occlusion when necessary and to keep in touch with the patient by having him come at regular intervals for check of visual acuity and reevaluation. The parents then do not become dissatisfied and feel that nothing is being done for the child, and they are not so prone to seek treatment elsewhere.

The age of the patient is a fundamental consideration also in the treatment of amblyopia by occlusion. In adolescents, the psychological aspect of this method of therapy must be carefully evaluated. If he is not willing to wear a patch, I do not feel that the patient in this age group should be forced to do so. The psychological upset may be more harmful than the amblyopic eye. With sufficient incentive, many of these children are anxious for an improvement in vision and will cooperate fully.

If low intelligence is the cause of poor response, orthoptics will not be of much value. Stupid children cannot learn to recognize their errors and correct them. The intelligence of the parents is of equal importance.

Whether or not the child is spoiled or in need of discipline is another factor to be considered. With proper handling most of these youngsters will become cooperative patients in the office; however, the relationship between parents and child at home may make home exercises impossible. Home training plays a very vital part in orthoptics. If it seems unlikely that home exercises will be performed regularly by the patient and conscientiously supervised by the parent, it is also unlikely that binocular single vision will ever be developed as a habit in his daily seeing.

I am sure that all of us in the South are constantly faced with the problem of the out-of-town patient. Some parents are willing to make any sacrifice to see that the child has the best treatment possible. However, in these cases the ophthalmologist must take the responsibility of advising the parents. It must be decided whether for this individual person the benefits gained and his future needs will be worth all of the time, effort, money, and physical and nervous stress entailed by the frequent long trips.

If the potential success of each case is carefully considered in all of its aspects before placing a patient on orthoptic treatment, many failures due to insufficient or haphazard treatment can be avoided. The end result and its importance to the individual must be weighed against the prob-

able difficulty and amount of effort required to achieve it. Even the mildest cases are tedious and time-consuming for the patient and his parents.

In summary, I would like to quote some remarks of Dr. Burian:[1]

> Not every patient who may be amenable to orthoptic treatment must be so treated. Obviously treatment should be given in all cases in which it may reasonably be expected that exercises may influence beneficially the manifest deviation. This holds true especially for all cases of latent deviation in which exercises may rid the patient of symptoms. If it is a matter not of reducing a deviation or of giving comfort but of establishing binocular cooperation, judgment should be exerted in the selection of cases. It may be the part of wisdom to leave some patients alone to rest content with a cosmetic surgical result. In cases in which the restoration of binocular vision may be expected to be a difficult long process, the effort expended on the part of the orthoptist, the child and the parents may be all out of proportion to the result achieved. The orthoptist had better devote herself to patients who are more promising or more in need of help. The child had better employ his time practicing music or some other useful skill, the mother had better use her valuable time in caring for her children and her many duties.

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A SIMPLE METHOD OF DETERMINING THE COORDINATE REQUIREMENTS OF CONVERGENCE

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IT is my purpose to describe a simple method of determining, in prism diopters, the exact convergence requirement of any patient for a given distance of fixation. In this method the fixation distance is expressed in focal diopters, that is, as the reciprocal of the fixation distance measured in meters. This means of expressing fixation distance in focal diopters is referred to as the "dioptric distance."[1] It provides a means of expressing the relationship of the accommodative requirements of an emmetropic patient to the coordinate convergence requirement.

How is this relationship to be determined for a given patient? The simple formula necessary for this determination can be derived by triangulation. Imagine that a patient with an interpupillary distance of 6 centimeters converges his visual axes from the parallel position so that they intersect at one meter. It is easier to visualize this convergence measurement by thinking of one of these two visual axes as crossing over to meet the other. To do this, it undergoes 6 centimeters of deviation (fig.1, a). This deviation, therefore, is equal to 6 prism diopters, since by definition each centimeter of deviation equals one prism diopter at this distance of one meter.

The basic formula, accommodative requirement expressed as focal diopters times the interpupillary distance in centimeters equals the convergence requirement in prism diopters, now is apparent. Let us see if this formula is applicable to other fixation distances. Taking this one step further, if the above visual axis deviation remains unchanged, that is, at 6 prism diopters, a perpendicular plane placed one-half meter away would leave 3 centimeters separating the visual axes at that distance (plane EF in fig. 1, b). Since this is only one half of the total tangential deviation needed to cause intersection of the visual axes at that distance, and since they are already converged 6 diopters, another 6 diopters, or a total of 12 diopters is needed. This answer also is obtained by the formula. The emmetropic patient accommodates 2 diopters at one-half meter. This required amount (2 focal diopters) of accommodation times interpupillary distance (6 centimeters) gives the required amount of convergence in prism diopters, that is, 12 diopters.

The formula for determining the convergence requirement for any fixation distance, therefore, is: Accommodative requirement of an emmetrope, in focal diopters, multiplied by interpupillary distance in centimeters equals coordinate convergence in prism diopters.

For the purpose of simplification in this paper, the emmetropic accommodative requirement expressed in focal diopters will be designated as "A" and the interpupillary distance as "p.d."; "C" will represent the coordinate convergence requirement expressed in prism diopters. Thus the formula in simplified form is: A $\times$ p.d. = C.

The term "convergence coordinate" is proposed to indicate the amount of geometric convergence in prism diopters required for the visual axes to intersect at any fixation (accommodative) distance.

From the Department of Ophthalmology, The University of Oregon Medical School.
Read at the meeting of the Western Section of the American Association of Orthoptic Technicians, April 30, 1954, Portland, Oregon.

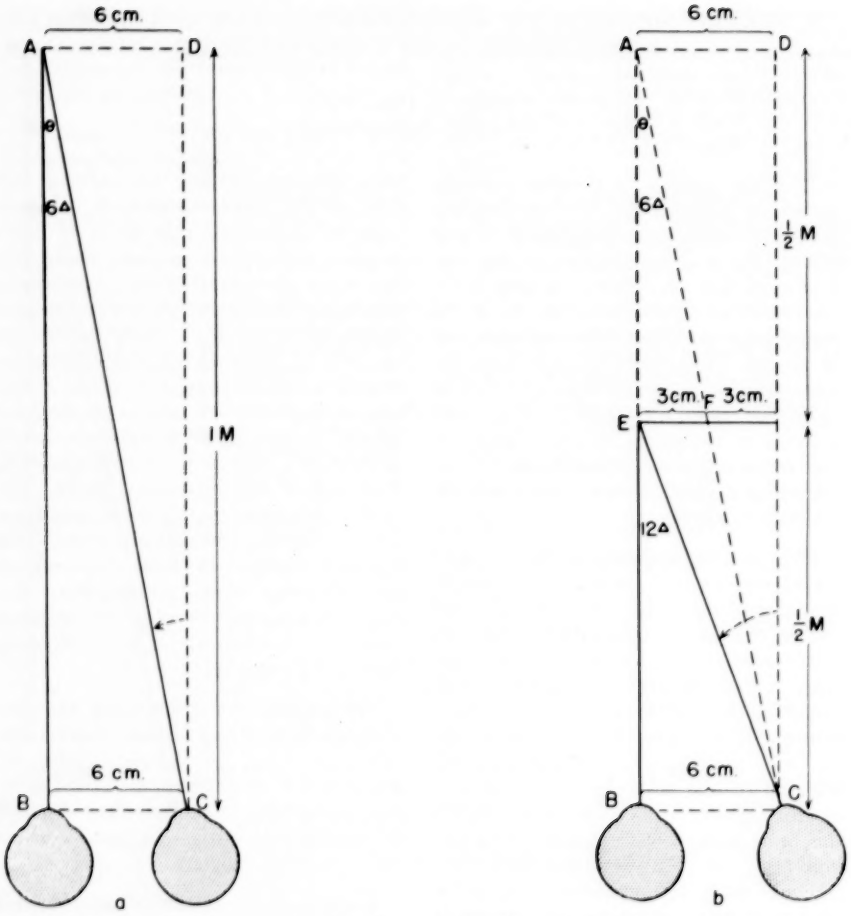

FIG. 1—Prism diopters of convergent angle as determined by right angle triangulation for fixation distances of one meter (a) and one-half meter (b).

This term is synonymous with "adduction coordinate," described in a previous paper.[1]

For the purpose of mathematical derivation, the right angled triangle of figure 1,a will be used. Geometric steps for the evolution of the formula have been presented in the Appendix of this paper.

As with any formula dealing with the constant relation of two variables to each other, we now have coordinate values which can be plotted graphically. These coordinates are accommodation and convergence. Differences in the interpupillary distance result in different values of convergence coordinate for each corresponding value of accommodation coordinate (fig. 2). For example, two patients, one with a 6.0 cm. p.d., and one with a 7.0 cm. p.d., when fixating on an object 33 mm. distant, require 18 and 21 prism diopters respectively in order to cause their

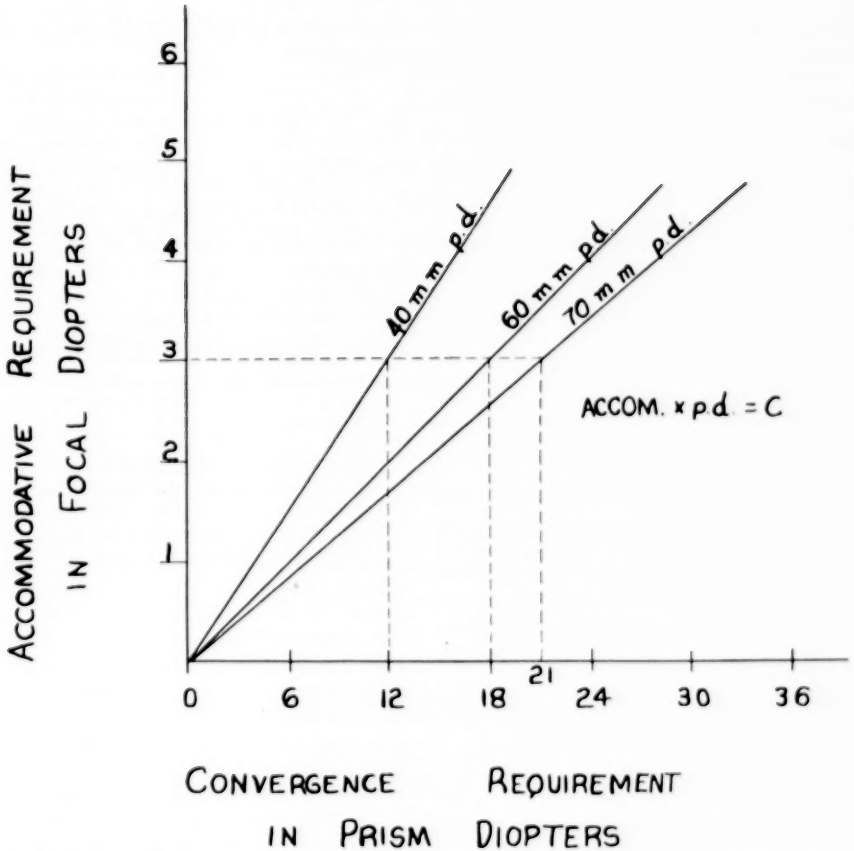

FIG. 2—The accommodative and convergence requirements of patients with different interpupillary distances.

visual axes to intersect at that point, as determined by the abscissas and ordinates of the above coordinate system. It should be remembered that this is a simple mathematical expression of the geometric convergence requirement when the patient's interpupillary distance and his fixation distance are known. It does not imply that the coordinate amount of convergence always occurs. The normal and abnormal pathologic physiology of convergence and some clinical applications of the convergence coordinate have been discussed in a previous paper.[1] Subsequent papers will cover other aspects.

SUMMARY

A simple formula is described which makes possible a rapid determination of the normal convergence requirement in prism diopters for any patient for any fixation distance. Derivation of the formula is described in a supplemental Appendix for study by those who desire mathematical proof of the formula.

REFERENCE

1. Hill, Robert V.: The accommodative-effort syndrome: pathologic physiology, Am. J. Ophth., 34:423-431 (March) 1951.

APPENDIX

If centers of rotation of the eyes are substituted for positions B and C in figure 1a, a simple calculation determines convergence requirement for the fixation point A as follows:

1. Angle θ now represents convergence of visual axes AB and AC.
2. Angle θ is determined in prism diopters by the tangential deviation of visual axis DC to the leftward along the frontal plane AD to its point of intersection A with visual axis AB.
3. Parallel lines are always equidistant; therefore, distance BC and AD are both equal to the interpupillary distance, 6 cm.
4. Tangential deviation of DC to point A occurred at a distance of one meter from the patient's eyes.
5. Therefore, by definition of prism diopters, angle θ equals 6 prism diopters (i.e., 6 cm. tangential deviation at distance of 1 meter = 6 prism diopters).
6. Angle θ is same for triangles ABC and AEF. Therefore, BC : AB : : EF : AE (i.e., all sides of similar right angled triangles bear the same proportionate relationship to each other).
7. By substituting values indicated in figure 1, 6 : 1 : : EF : 0.5, therefore, EF = 3 cm.
8. Inasmuch as angle θ still represents 6 prism diopters, and the intersection of visual axis AC at frontal plane EF is equal to only one half of the deviation necessary for it to intersect at point E, a total of 12 prism diopters deviation is required for this intersection at E; therefore, each centimeter of deviation at this distance represents 2 prism diopters.
9. Distance EB (0.5 meter), which can be expressed as "dioptric distance" as the reciprocal of this metric distance, i.e. 1/0.5 = 2, multiplied by the patient's p.d. (6 cm.) = required 12 prism diopters convergence.
10. The formula, therefore, is: emmetropic accommodative requirement, or "dioptric distance," times the interpupillary distance (in centimeters) equals coordinate convergence requirement (in prism diopters), or, in abbreviated form: A $\times$ p.d. = C.

A SIMPLIFIED AFTERIMAGE TEST FOR RETINAL CORRESPONDENCE

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IT is the purpose of this report to describe a simple technique for creating afterimages. This technique has been used at the University of Oregon Medical School primarily to determine the state of retinal correspondence in patients with strabismus.

The introduction of afterimages for the study of retinal correspondence is due to Hering. Afterimages were first used as a means of investigating anomalous retinal correspondence by Tschermak in experiments on himself, and simultaneously by Bielschowsky on a large group of clinical patients. These authors stimulated first the vertical meridian of one eye with a vertical line of light from a showcase incandescent lamp, and then the horizontal meridian of the other eye with a horizontal line of light. The lamp was provided with a ring at its center, bearing a fixation mark. In this fashion the fovea itself was protected from stimulation and the resulting afterimage in each eye consisted of a line with a gap in its center. These gaps represented the foveas; if the two had a common visual direction only one gap was seen, the vertical and horizontal afterimages forming a cross. If the two foveas did not have a common visual direction, that is, if retinal correspondence was abnormal, there would be two gaps and the two afterimages would appear separated by the angle of anomaly.

The validity of the afterimage test for the determination of the state of retinal correspondence has been confirmed by many observers during the past half century; however, the test has not been used routinely in ophthalmologic practice because of the difficulties of conducting it, particularly in young children. The standard technique consists of utilizing a long filament of incandescent light such as a showcase lamp. A black center ring with a fixation mark is placed half way along the filament. The filament of light is placed in the vertical position in front of one eye, and then the patient fixates the black center ring on the light for at least ten to fifteen seconds with this eye. Then the filament of light is switched to a horizontal position and the patient fixates the globe for another ten to fifteen seconds with the other eye. He describes or draws on a board or paper, the relative position of the two afterimages as he observes them.

The standard technique described above has several disadvantages. In many young patients it is difficult to create a lasting afterimage so that often the afterimage in the first eye is lost before the afterimage can be created in the second eye. Furthermore, it requires that the patient maintain accurate fixation at a point in the center of a bright light source. The glare often is uncomfortable and results in variable or inaccurate fixation.

At the University of Oregon Medical School, we have modified the technique in two ways. We routinely adapt our patients to the dark before conducting the test because afterimages are most intense in a dark-adapted eye. Dark adaptation usually takes place within a matter of ten minutes, but it is not necessary to place

From the Department of Ophthalmology, The University of Oregon Medical School.
Part of a study being conducted under a grant from the Oregon State Elks Association.
Read at the meeting of the Western Section of the American Association of Orthoptic Technicians, April 30, 1954, Portland, Oregon.

the child in a darkened room for this period. Instead, the red plastic goggles worn by radiologists for dark adaptation prior to fluoroscopy can be placed over the child's eyes; the frightening effects of darkness are thereby eliminated. Our second modification has been to substitute for the showcase lamp, an electronic flash unit of the type commonly used in physicians' offices for clinical photography. These electronic flash units produce a very intense flash of light of short duration. The patient therefore is not required to maintain fixation on an intense light source. Furthermore, the afterimages can be created in both eyes within a matter of seconds. This has the advantage that afterimages of comparable intensity can be induced.

At present we are using a Heiland Strobonar I electronic flash unit. This is an inexpensive, small unit which produces an intense light which lasts only 1/1000 of a second. We have prepared a simple plastic hood which fits over the light. The plastic hood is black to prevent loss of dark adaptation and has a slit which is two inches long and one millimeter wide. A quarter-inch square of white adhesive tape is placed across the center of the slit with a black dot for fixation. The small dot ensures accurate foveal fixation and the tape creates a gap in the afterimage which permits the patient to align the afterimages accurately.

Our technique is as follows: The patient wears the red goggles for at least ten minutes before the test is undertaken. The electronic flash unit with the plastic hood fitted over it is used at one-half meter distance. The patient is asked to fixate the black dot on the white background with the line held vertically before the usually deviating eye, and then horizontally before the usually fixating eye. When the afterimages have been created, the patient is asked to locate the afterimages on a piece of white paper held one-half meter in front of the eye. We have found that with small children, more accurate and rapid subjective responses are obtained when the examiner draws a vertical line on the paper and asks the patient to draw in the horizontal line where he sees it in relation to the vertical line.

The method described above has been quite successful even with preschool children. It has given us more consistent results in the determination of the state of retinal correspondence than has been possible with the standard techniques of conducting the afterimage test.

SOME TECHNIQUES FOR THE ANALYSIS AND TREATMENT OF SUPPRESSION

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EVERY experienced technician finds that breaking down suppression consumes the major portion of the time spent on orthoptic lessons. In the presence of suppression, fusion cannot exist. If the suppression is partial, then partial fusion may exist. If it is intermittent, then fusion may exist part of the time.

Fusion may fail because of either motor or sensory factors or a combination of both. If the patient cannot get fusible images on the corresponding areas of the two eyes, he cannot proceed to sensory fusion. In this discussion it will be assumed either that the patient has motor fusion or that the ophthalmologist anticipates securing it by surgery or prism correction following orthoptic treatment. It is also assumed that the patient has normal correspondence and that the corresponding areas are the foveas of the two eyes.

A patient who has two eyes with reasonably good visual acuity can adjust to the problem of binocular vision in only five ways:

1. He can fuse normally
2. He can tolerate diplopia
3. He can suppress one image
4. He can develop anomalous correspondence
5. He can develop the blindspot mechanism

In the presence of obstacles to normal fusion, the commonest adjustment is by suppression. This may be partial or total, constant or intermittent, uniocular or alternating, or a combination of these types.

From the Sacramento Orthoptic Laboratory.
Read at the Meeting of the Western Section of The American Association of Orthoptic Technicians, April 30, 1954, Portland, Oregon.

It is therefore the duty of the technician to find out how the patient is using his eyes (adapting to binocular vision), to create situations in which it is easier for him to use them better, and finally to find out whether he is taking advantage of these situations to do so. Each step offers its special problems. I shall discuss each in turn.

HOW IS THE PATIENT SEEING?

The exact answer depends upon the philosophical concept of normal vision; how does anyone see? There is no perfect answer to this question in the science of opthalmology. There are only some commonly accepted assumptions. Normal human eyes "see," or "perceive," a single integrated image, a composite of the images received by each eye, having form, color, and location in space. During a lifetime of experience in seeing such images, the individual builds up a vast body of associations, interpretations and meanings about them. These interpretations are susceptible to change. During infancy and early childhood the character of the images is also gradually changing as the eye grows, and as its mature anatomy develops. The image becomes clearer and is more firmly maintained on the fovea as accommodation and motor control improve. Whenever a refractive error is corrected, or surgery is introduced, a more sudden change in the character of the images takes place, and the patient has to make a correspondingly quick adjustment.

Nature has implanted an instinctive desire for one type of image—a single clear one. To achieve this, Nature requires us to abhor blur or diplopia. If, by abandon-

ing fusion, we can achieve a clear single image, Nature has no great objection. Since the mechanism of fusion permits only objects on the horopter to be fused, normal eyes get abundant experience in suppressing diplopia and the blur of objects not on the horopter. This skill is easily extended to any other images which seem to the patient too difficult or distressing to fuse.

The study of blur, or accommodation failure, is not in the scope of this paper and will be omitted.

The question then becomes, "Does the patient see 'one' or 'two'; has he single vision or diplopia?"

If he has a single image, is it obtained from monocular clues only, or is there total, or partial, integration of binocular images?

If he sees two images, what is his interpretation of the relationship between the two images? In this last question lies the most common source of error in making an orthoptic analysis. Sometimes it is very difficult to find out how the patient is seeing his two images, but a common cause of careless diagnosis is due to failure to keep in mind at all times the various possible interpretations.

The most frequently ignored interpretation is relationship in time, which is quite distinct from relationship in space.

The word "two" in the English language may mean two simultaneously, which is relationship in space, or two consecutively, which is relationship in time. They are not the same thing, and the use of the word "two" does not differentiate them. There is nothing in the process of learning to talk that teaches the child, or even most adults, to distinguish between these meanings, but it is the very heart of orthoptics. "Two" in space means simultaneous perception and the absence of suppression, whereas "two" in time means alternation and the presence of suppression. Many failures in orthoptic training are due to the use of this word interchangeably to indicate both time and space relationship. If I mean simultaneous perception when I use the word "two" and if the patient means alternation, we are as far apart as the poles in interpreting how the patient sees. This problem is frequently brought to my attention in two ways: the ophthalmologist will sometimes tell the mother that the child is "seeing double" as a convenient (?) way to describe strabismus, and the mother takes it literally. This sometimes leads the child to pick up the word and complain that he has diplopia. I have found it extremely rare for a child to have diplopia, except briefly following surgery; Nature protects his single vision! Secondly, patients go through orthoptic training with emphasis on the recognition of diplopia and claim success, when a careful analysis shows their "two" is consecutive (time relationship) and not diplopia (space relationship).

It is the duty of the technician to achieve real success: simultaneous perception and not alternation.

TECHNIQUES FOR DETECTING THE RELATIONSHIP OF TWO IMAGES

I. The simplest way to discover relationship in time is to *watch the eyes of the patient.* If an eye moves, it is not receiving a sufficiently stable image for interpretation in space; there is no diplopia. My favorite phrase is to say to the patient, "Nothing counts if your eyes have moved just before or while you are speaking." A statement from the patient is acceptable as evidence only in the presence of binocular stability. He must fix on an object (usually a button on a swab-stick handle) and keep his eyes still before he is permitted to say "one" or "two." Moreover, I require him to use exactly those brief words with no flowing sentences about "Now I see two horses." I have observed that children use wordiness to escape from making accurate observations, rather than as a tool for reporting them. The fewer words, the more probability of accuracy. Also, in the time consumed for speaking

several words the eye status is more likely to change. Stability which can be maintained for one word is frequently impossible for several words. Note that when the patient has made his report with his eyes still we do not have *proof* of his visual pattern; we have one piece of evidence which is our starting point.

If the patient does have two simultaneous images, they have location or relationship to each other, and it is possible for the patient to describe such relationship, especially to describe *changes* in relationship such as "closer together" and "farther apart." The technician must have the knowledge and skill necessary to check the correctness of the patient's claims; he must know where the second image would be located if it were there, and how to change its location by prisms, by distance, or on the amblyoscope. Such skill is taken for granted in all my subsequent discussion. It depends, of course, upon the angle of squint, distance of the point fixated, and type of correspondence.

II. When the patient says "one," the technician must decide whether there is a possibility of fusion. The patient may be seeing a single image for the perfectly normal reason that he is fusing. The simplest way to decide this is by a *combination of inspection of the patient's eyes*, especially the corneal reflexes, and use of *the cover test*. In the presence of possible fusion, the corneal reflexes will be correctly located (allowing for possible angle kappa) and there will be no movement of redress on using the cover. These are elementary techniques, but their use for studying suppression status, instead of merely for making measurements, is too often neglected. If there is manifest deviation, or movement of redress, the single image is the result not of fusion but of suppression.

III. The presence of the diplopia image may be determined by requiring the patient to locate the second image correctly. In the absence of diplopia he will be unable to do so. When the patient says "two," if he is actually perceiving two images, and not "faking" his statement, then the second image has location. A little ingenuity enables the technician to change the location of the second image so that the patient cannot "outguess" her; the simplest method is to change the location of the object fixated by moving it closer to, then farther away from, the patient. Another change consists of mechanically altering the vision of the patient's fixing eye with a cover: a vertical prism may be used, or a lateral prism.

The chief difficulty in evaluating the patient's reports on location of secondary images results from the extreme instability of the beginner in binocular experience. He may have such fleeting binocular perceptions that he has no time to locate an image before it is suppressed. It may exist at the moment of speech and disappear before it can be talked about in detail. There is usually some evidence of the loss of the image, such as a movement of the eye.

IV. If the technician is satisfied that the patient does *not* have diplopia (and is not fusing), the next task is to *find out under what conditions diplopia can be aroused*; i.e., how difficult it is to break down suppression. This is the most important clue to prognosis in orthoptic training.

There are two useful approaches to this problem. One is by making the image very stimulating, as by the use of a bright light. The other is by making the two images differ so that the patient is made aware which image is "missing." This is accomplished by a red filter. Some technicians always study fixation patterns by using a light for fixation; I do not do so because I want to study how the patient uses his eyes under conditions as close to normal as possible. I consider a light a definite step toward "artificial help," a technique for breaking down suppression rather than for merely studying it. However, it is possible to proceed from "success" in getting

diplopia on a light to "failure" to get it on a button, instead of the reverse, if the technician so chooses. If, even with a light, there is no recognition of diplopia, the next step is to use a red filter over the better (fixing) eye, or the right eye if there is no basis for choice.

V. In the *red filter sequence technique*, each step should be carried out in such a way that failure to arouse diplopia really means the presence of suppression and not merely a failure to understand what is wanted, or lack of attention to the situation, or lack of vocabulary to describe what is seen. A high degree of confusion exists among technicians as to what a patient sees because he is allowed to describe his perceptions in words which have different meanings for patient and technician.

I have already discussed relationships in time and space. When color is added to the situation, it is more difficult than ever for the patient to be accurate, and even more care about the use of words must be exercised. The phrase "red and white" is a triple pitfall. In the English language the conjunction "and" may be said to be used correctly if it means (a) simultaneous, (b) consecutive, or (c) mixed. Hence my first warning to the patient is that the words "red and white" are *never* permitted! Before using the red filter, I show him two buttons, one red and one white, and demonstrate how I want him to describe them: If side by side (simultaneous) he is to say "two." If one after the other, he is to say "red" when he sees the red one and "white" when he sees the white one and omit the word "and" entirely. If they mix, he is to say "different." Later in his training I teach him the word "pink."

With the red filter (which dims as well as colors) placed over the better eye, the patient is told to "choose the one he will look at, red or white." When he has made his choice, the technician must watch for the slightest movement of the eye which would mean loss of fixation. *If the patient cannot control his fixation, no statement about his perception of one or two images is acceptable.* When the eye moves I say, "That did not count; your eye moved." To help the patient understand what is expected of him I make statements such as "You are looking at the white one; is the red one also there?"

If the patient does not get diplopia within three to five minutes of coaching, I consider that diplopia does not exist for casual seeing and must be aroused by more artificial means. I move him to the major amblyoscope.

If the patient says he sees two, and the statement is acceptable due to an appearance of stable fixation, I require him to locate the second image. He now has color to guide him and can report which side the red one is on. The use of left and right is unreliable with a young child. It is better to refer to some object in the room, such as door side or window side. I never permit him to point to a second image, since it involves a motion of the body which makes study of his fixation very difficult, and there is very apt to be a change in fixation associated with the pointing which invalidates his observation at once. If the second image is in the right direction (crossed or homonymous, in agreement with his strabismus) he must next describe how far apart they are. A helpful question is "Is there room for one button in between, or two, or three?"

If the patient is able to make an accurate report on the location of the second image at near, I require him to make the same attempt at a greater distance, such as on a wall target at four feet. He may be asked to walk slowly to and fro and to describe changes in the spacing of the images. At all times his eyes are under close observation for loss of fixation, alternation, or any instability. If he succeeds in all these tests for diplopia, he is then tested without the red filter.

The following information is gained during this testing process: (a) how deep the

patient's suppression is; (b) how mature his observations are; (c) how amenable he is to my teaching technique; and (d) the orthoptic prognosis for developing binocular fixation (as distinct from vergence control or reducing the deviation). There are clues to vergence control and to anomalous correspondence during these tests, but better information about those factors is gained in other ways.

VI. The key to reliable *diagnosis of suppression on the amblyoscope* is to keep the patient fixing with one eye while he reports the status of his perceptions with the other eye. This seems a simple statement, but very few technicians take the trouble to ensure that such fixation persists long enough to give the novice patient an opportunity to make reliable observations.

There has been an increasing tendency for technicians to use foveal targets for their work, whereas at the same time research is showing the extreme importance of peripheral fusion. Too much reliance on foveal targets means that the patient is denied the opportunity to use peripheral fusion. If peripheral fusion plays the part which we are beginning to suspect in casual seeing, it does not seem a sound approach to orthoptic training to eliminate it to any great extent. The behavior of a patient while looking at foveal targets in an amblyoscope does not seem to be an accurate guide to his behavior on casual seeing. I suspect that foveal targets are popular because they make observation of fixation easier for the technician.

The object of a study of suppression should be to find out how good and useful the patient's fusion is, which means how far up the ladder has he climbed by himself. Large macular targets offer the ideal stimulus to fusion, but permit the patient's eyes to roam over the surface while still "looking" at the target. The large target should have detail for central fixation, and the checkmarks should be located close to this center so that they may be readily observed in the absence of suppression. Check marks off to the side are not easy for the patient to observe and discuss with the technician without exploratory movements of the eyes which are fatal to the steady fixation necessary for studying suppression.

Should a simultaneous perception or a fusion target be used? Simultaneous perception is more difficult for the patient, but easier for the technician. A patient who has simultaneous perception has fusion when a fusion target is substituted. But a patient who can fuse may not be able to percieve or interpret simultaneous perception, since he does not have the advantage of the fusion reflexes to help (optokinetic and optostatic). Since this paper is concerned with the study of whether patients suppress images which should be fused, we can skip over the technique of using fusion-free (SP) targets to establish the location of the foveal images by means of the corneal reflexes. For convenience I will discuss my techniques in terms of the AAOT prize targets, which are readily available, although none of them fully meet my wishes for a beginning target that is very large and has central check marks.

The target showing a cowboy with red and green guns is fairly satisfactory. The patient is shown first one target and then the other by flashing the correct light. The difference between the two pictures is explained and the correct words "lost red" and "lost green" are repeated several times. He is then told to fix on the star of the glove while the targets are set for probable fusion, and he is asked if "both colors are there, red and green." His eyes are studied for loss of fixation (alternation). If he replies without motion his answer is accepted. If he sees only one, stimulation is given until he sees both. If he is successful, a target with less peripheral stimulation is selected, and the process is repeated. Stereoscopic targets are used as a final check on his fusion stability. The interpretation of stereopsis requires reasonably stable fusion. Patients who never report a loss of

check marks and who manifest no loss of fixation may still have some intermittent suppression which can best be detected by their inability to perceive stereopsis. Conversely, many patients who have no vergence control (amplitude) are able to get sufficiently stable fusion at their deviation to perceive stereopsis; they suppress when the image is moved off the fovea, and vergence control would be necessary if they were to keep the images on corresponding areas. Other patients suppress the image when it does correspond. If the amblyoscope is set so that the reflexes are located for fusion, no movement of the eye is detectable which would help the technician discover the presence of suppression. Only the patient himself can detect the presence of suppression in such cases. *This is why correct overt response is so essential to efficient orthoptic procedure.* Fusion is a subjective process. All objective tests to evaluate it are only approximate. No matter how carefully the technician prepares the situation for easy fusion, the patient may or may not accept the process in his brain known as "fusion." When he suppresses, he is refusing this process. Suppression may be partial or total, constant or intermittent, but in making the analysis, whether it is for the first time or in an effort to discover how far the orthoptic correction has proceeded, the technician must not be fooled by relying on wholly objective tests or on wholly subjective reports by the patient, which are often erroneous. The two appproaches must be coordinated and evaluated, the objective with the subjective, for the most reliable conclusions. The better and more accurate each approach can be made, the more reliable the conclusion will be.

VII. The technician has only himself to blame if he has not learned to make accurate observations of the objective status of the patient, with superb skill in noting the slightest movement which indicates loss of fixation. *To build up reliable subjective evidence from the patient* is a separate technique. It requires three steps: (a) the patient must *find out* how he is seeing; (b) he must *know how* to communicate his findings; and (c) he must *make an overt response* which does communicate these findings to the technician.

Most patients are quite unaware that there are different ways to "see" the same object: that they may see with the right eye, the left eye, with both eyes with fusion, or with both eyes without fusion (diplopia). If, on casual seeing, the patient changes from one method to another, he is rarely aware of the fact. The extreme value of the major amblyoscope lies in the convenience and speed with which the different ways of seeing can be presented to the patient for his observation and interpretation. More than any other invention, the amblyoscope makes it easy for the technician to grade the material offered for observation and guide the patient into making correct interpretations. If the patient is too immature to make the simplest observations on the amblyoscope, he is not amenable to orthoptic correction by the learning process and only neuromuscular stimulation at the reflex level can be carried out; no true study of the suppression status can be made, and the technician can only hope that such stimulation is helpful in the development of binocular vision.

If the patient can make observations on the amblyoscope, he must be given clear, obvious, and dramatic changes to notice. Many targets are so cluttered with detail that it is very difficult for the patient to concentrate on the ones that matter, which are the check marks. If the patient is being taught to observe that the lion is "in" or "out" of the cage, sweeping motions of the handle should move the lion to and fro until the beginner is ready to interpret closer relationships. Fusion targets should have bold, vivid areas missing for check marks. The technician should express satisfaction and pleasure freely when the pa-

tient approximates correct observations, waiting for accuracy to come with experience.

The patient may be observing very well; how can the technician find out? Only by the response of the patient. To avoid confusion and reconditioning later in the lesson series, the technician should teach the patient from the very first lesson exactly how to communicate his observations clearly and promptly. Verbal responses are the most useful, but responses involving eye-hand coordination such as in and out or chasing practice on the amblyoscope require the same careful coaching.

The patient and technician must agree on the meaning of words and gestures. The best way to make this clear is to analyze some common problems. "In" for some patients means "in sight" and not necessarily "in the cage." These situations are not at all the same thing, and to communicate the difference the patient must be taught the acceptable use of "in." "Out" and "out of sight" are even more frequently confused and the results are even more disastrous since the one denotes suppression and the other diplopia.

The meaning of "two" is so important that it is worth emphasizing again and again that it may mean either alternation or diplopia; no pains should be spared to teach the patient to differentiate these observations.

On the amblyoscope the detection of suppression centers on the observation of the loss of suppression marks. All observation should concentrate on this important finding, and the patient should be consistently discouraged from making observations about irrelevant material which does not disappear. This is especially important in connection with perceptions of the recovery of a check mark which has been suppressed. Thus, if the "red gun is lost," it is not the recovery of the red gun which is important, since this can easily be achieved by changing fixation to the other eye; it is recovery of the red gun without losing the green gun which is desired. Hence the observation "lost red" should be followed by the observation "perfect," and *not* by the observation "He has it again," or "I found the red one."

When the patient can make accurate and useful observations about check marks, he must next be taught to make similar observations about diplopia.

At the same time that the patient is trained to make observations, his responses are being developed. The two cannot be separated in practice, although for discussion I would like to emphasize briefly that it is *only* by his responses that we find out the character of the patient's observations. There is no point in developing superb responses based on careless and sloppy observations, and yet I find that many patients, referred after training by other technicians, haven't the remotest idea what they are talking about when they glibly report seeing "two." Most alternators quickly pick up the idea that they are "seeing double" but have great difficulty in developing diplopia.

VIII. Very early in his training I start the patient on *red filter practice with flash cards* so that he can transfer his skill in observation and response to the problem of reading as soon as possible. A red filter placed over the fixing eye, a plain white card (the back of an appointment card is useful) and a cover are the only equipment.

Each eye is covered in turn and the patient is taught to say "red" and "white." He is then taught the following sequence as fast as he can learn it: With both eyes exposed, to change from red to white. With eyes closed, to "choose" a color and promptly fixate it when eyes are opened. To fix on one color and "see if the other one is there." If not, to report "which color is missing." If it is there, to make such report without loss of the color first fix-

ated (true diplopia). To describe the location of the second color—its "side" and "how far away." At all times he is coached in the correctness of his observations: "No, that is wrong, try again." When observations are consistently wrong, progress is discontinued until that step is mastered, days or weeks later.

If there is a possibility of fusion, the concept of "pink" is next introduced. Since the exact character of the blended color is indescribable, the word "different" (from red or white) is used at first. When a patient can get a blank card pink, a picture card for the nonreader or words for readers is introduced and he is taught to watch for diplopia to the printed matter. This is a very important step in proceeding from peripheral fusion which permits mixing color, to foveal fusion, which is necessary for fusion reading.

Some patients with peripheral fusion may be dismissed as satisfactory. However, the technician should know whether the patient who is doing "pink reading" is suppressing the diplopia to the print, which *should* be present if he has failed to get perfect foveal fusion. When his fusion on flash cards with single words is satisfactory, he is promoted to reading in a book. Careful training in this diplopia to print is equivalent to bar-reading.

IX. A patient who can make accurate correct observations and responses on the amblyoscope and with red filter (which may be achieved in one lesson or one year) should transfer to a situation as close to casual seeing as possible. For this I like *wall targets* best. I use Christmas or other holiday stickers pasted at convenient height for eye-level practice at distances from two to six feet. Subsequently, the patients transfer to doorknobs or light switches around the room.

The patient must fix steadily with one eye. Most patients are more expert in suppressing one eye than the other. If the patient fixes with the habitually suppressing eye, the other eye is more likely to refrain from suppression, permitting the patient to experience diplopia. Eventually he must be able to fix with either eye.

Any motion means loss of fixation. It is common for a patient to be intolerant of steady fixation and to make "avoidance movements." Steady fixation often results in lacrimation — an encouraging sign of orthoptic progress, since it will not occur if he is *not* fixing steadily. If the patient stands about 3 feet from the wall and the technician sits halfway between wall and patient, one hand can be used for the cover test on the patient's eyes and the other to point to and discuss the location of the secondary target. After the patient spends a few moments looking at the wall target, the technician can tell when the fixation is steady enough to warrant discussion of the second image. *When it is not there, it cannot be discussed.* The technician must be capable of saying "No, you are wrong" when the patient claims diplopia which is not existent, i.e., in the presence of motion of the eye.

The patient must locate the second image. This requires sufficient endurance in maintaining binocular fixation to permit observation and discussion. The minimum limit is one-half minute or fifty counts. This unit of endurance is ideal for home practice. As soon as the technician is confident that diplopia exists, the patient is dismissed until he can hold fifty counts at home; he then returns for more advanced work. This is an excellent device for determining how good the home cooperation really is.

It is gratifying to find that some patients with intermittent tropia are unable to hold diplopia for 50 counts because they promptly fuse! Unfortunately, most patients "lose" the second image and mistakenly claim "fusion," which event can be quickly detected during an office visit.

During the period when binocular fixation with diplopia is fleeting, a gross observation of the direction of the second

image should be acceptable. With increasing stability, it becomes possible for the technician to "touch" the second image. Sometimes the patient can learn to touch his own secondary image with a light pointer or yardstick. He is no longer suppressing and is a candidate for vergence control!

The patient may take steps to and from the wall, noting the corresponding change in the location of the second image. He may learn to transfer fixation, changing the image to the other side. Physiological diplopia may be conveniently introduced at this stage. Patients with peripheral fusion and foveal suppression often may perceive two bars but not perceive the diplopia to the target which their deviation shows should be present. This very useful phenomenon of bar practice is too often ignored. It is a valuable technique for helping to break down difficult foveal suppression.

X. In addition to developing visual control, the technician should constantly be trying to *develop in the patient an intellectual curiosity about the status of his eyes* so that when errors occur, he will notice them and use his newly acquired orthoptic skill for correction. I find my "three kinds of one" game invaluable for this purpose. The patient is requested to look at a wall target. "What do you see?" "One horse." "How many kinds of one are there?" "Three." "What are the three kinds?" "One with my right eye, left eye asleep. One with my left eye, right eye asleep. One with both eyes." "Which kind do you see?" "I don't know."

Children simply hate to admit that they don't know the difference between a single image by fusion and a single image by suppression, and when the technician can really convince them that this is a sad but true state of affairs, a tremendous step forward is taken. I encourage the family to learn this question sequence and fire it at the patient on all occasions, usually omitting the naming of all the kinds of one. It then becomes a speedy quiz: "What do you see?" "One nose." "How many kinds of one are there?" "Three." "Which kind do you see?" "I don't know!"

After this sequence is thoroughly understood, I proceed to say, "Let's find out," and I teach the application of the red filter as a technique which promotes the child to the head of the class, where they do know, by the color. Finally I use the bar and physiological diplopia, with the finger as a bar for checking the patient's status on casual seeing.

The requisites for fusion are adequate visual acuity, perception of the images from both eyes, and motor control so that the fusible images fall on corresponding areas of both eyes. The development of visual acuity by correction of any refractive error and by occlusion is the essential preliminary to orthoptic training; but unless the goal is cosmetic correction only, it is futile to proceed to the development of motor skills until the intermediate step of binocular perception is carefully and thoroughly established. Motor failures are dramatic and noticeable, and their correction may be very quick and spectacular when surgery is used. The teaching of normal sensory fusion when a patient has a history of adaptation to faulty sensory perception is much slower and more tedious. It challenges the utmost skill and patience of the technician.

The Development of Orthoptics in British Columbia

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BEFORE proceeding with the history of the development of orthoptics in British Columbia, I should like to review briefly the history of the origin of orthoptic training schools in England, where they were first established.

Dr. E. E. Maddox, the celebrated eye surgeon, originally suggested training young women in orthoptics for the reason that orthoptic training usually required an extended number of visits to a doctor who was much too busy to give the time that it required. Under the inspiration of her father, Mary C. Maddox took up orthoptic work in 1919, and eleven years later she founded the first orthoptic clinic in England, at the Royal Westminster Ophthalmic Hospital in London.

In 1933, the British Orthoptic Board was formed for the purpose of protecting patients by regulating the qualifications and training of orthoptists. Candidates were required to have "school certificate or matriculation" standard of education and had to study for one year in an orthoptic clinic of one of the hospitals organized by the Board, and they had to satisfy a board of examiners as to their ability and efficiency. The first examination was held at the Royal Westminster Ophthalmic Hospital, London, on July 3, 1934.

In April, 1937, the heads of the Hospital Orthoptic Clinics arranged a meeting of ophthalmic surgeons and orthoptists to hear a series of papers on orthoptics. The meeting met with such enthusiastic response that proposals for the "Standards of Cures" were drawn up and the British Orthoptic Society was formed with Miss Maddox elected as president.

Turning now to British Columbia, we find that in 1937, as the result of an article published in a British Medical Journal which outlined the training of young women in orthoptic work by Miss Maddox, a group of ophthalmologists became inspired with the idea of securing one of the girls trained by Miss Maddox and establishing an orthoptic clinic in Vancouver. Dr. Colin Graham, who was keenly interested in orthoptics, took steps to obtain one of the English graduates. At that time, all students in training were sponsored by English eye surgeons, and each one was expected to serve her sponsor upon graduation; hence, no graduates were available.

It was not until the spring of 1940 that the services of Marianne Eyles were obtained, and in May of that year the first orthoptic clinic was established in the Medical Dental Building in Vancouver. A committee of four ophthalmologists, consisting of the late Drs. Colin Graham and J. A. Smith, and Drs. J. A. McLean and C. E. Davies, was appointed to supervise the clinic, and Mr. Harry Boyanner was appointed as business administrator. The clinic was organized and continues to operate on a nonpaying basis and was the first clinic to be conducted on a group plan. The clinic functioned successfully from the start and soon Miss Eyles found herself extremely busy. In the autumn of 1940, two students were enrolled to take a course in orthoptic training following the curriculum of Miss Maddox' training school in England. The doctors of the com-

Read at the meeting of the Western Section of the American Association of Orthoptic Technicians, April 30, 1954, Portland, Oregon.

mittee gave unstintingly of their services in the way of lectures and demonstrations, and in the autumn of 1941, the students were graduated. From then on, two or three students were enrolled each year and graduated a year later.

In 1942, Vancouver had the honor of welcoming Miss Maddox, now Mrs. Arthur Lowndes Yates, along with her husband, Dr. Yates, and two children as residents. The committee of the orthoptic clinic immediately arranged with Mrs. Yates to supervise the training of students. Although Mrs. Yates later moved to Calgary, Alberta, she agreed to continue as supervisor and made frequent trips to Vancouver to conduct interim and final examinations. Those of us who were fortunate enough to train under her guidance feel that we gained much from her vast knowledge and experience in the orthoptic field.

In 1947, an orthoptic clinic was established in Victoria, British Columbia, and was operated for a number of years by Anna Taylor, a Canadian who was graduated in orthoptics from Washington University School of Medicine, St. Louis, Missouri. This clinic, like that in Vancouver, is conducted on a nonprofit basis and on the group plan. In the intervening years, a number of orthoptists have gone into private practice in ophthalmic surgeons' clinics throughout the Province.

Through the energy and foresight of Dr. Donald Paterson, who felt that Vancouver was greatly in need of a health center for children, funds were raised for such a project by private and public subscription, by subsidies from the Dominion and Provincial Governments, and from the City of Vancouver. The Health Centre for Children was incorporated under the Societies Act in March 1949, and now embraces an inpatient and outpatient department. In May of that year the orthoptic clinic in the Health Centre for Children was opened with June Lawrence in charge. It was soon made evident by the daily attendance and by the report on the Survey on the Crippling Diseases of Children taken in the Province in 1948-1949, in which some 786 children were found to have squints, that the services of orthoptists would be required not only in Vancouver, but in clinics throughout the Province. In order to institute such clinics with properly trained personnel, it was felt that the training of such personnel should be transferred from the Vancouver Orthoptic Clinic and become instituted in the Health Centre for Children, where a broader scope of training could be made available to the students.

The course commenced in November, 1949 under the guidance of Dr. J. A. McLean, clinical assistant professor of the Department of Ophthalmology at the University of British Columbia and chief of the Department of Ophthalmology at The Vancouver General Hospital. Permission was obtained from Dr. Frank D. Costenbader, secretary of the American Orthoptic Council, to conduct the course by regulations governing the training of orthoptic technicians for the American Orthoptic Council, and arrangements were made for the students to sit for the Council examinations. Four students have been enrolled each year, and of the twenty who have taken the Council examinations, only one has failed to pass. This year, five students are preparing to sit for the examinations, and applications received to date for next year's course have more than tripled those of previous years.

The didactic training is augmented by assisting at biweekly clinics held in the adult outpatient department in The Vancouver General Hospital, refraction clinics held in the orthoptic clinic, by observation of intraocular and squint surgery, by weekly visits to the Vancouver Orthoptic Clinic during the last three months of training, and by a visit to an optical company. During the course of training, the students are required to prepare at least two papers per month at home. Practice

papers are written, and symposiums are presented by the students themselves during clinic hours; test papers and mock examinations are given during the last three months.

The teaching staff consists of Dr. E. F. Raynor, Chief Consultant in Ophthalmology to the Health Centre for Children, and the attending staff of ophthalmologists of The Vancouver General Hospital, who teach on a rotation service, and one full-time orthoptist and teacher.

To give some idea of the amount of clinical work done in the eye department of the Health Centre for Children, a few statistics are necessary. During the first twelve-month period from September 1948 to August 1949, a total of 980 visits were made to the clinic. Of this total, 424 were to the biweekly eye clinics, 97 to the refraction clinic, and 369 to the orthoptic clinic. In 1953, the total number of visits made was 3746; of this number, 1278 visits were to the biweekly eye clinics, 887 to the refraction clinic, and 1581 to the orthoptic clinic. During the first three months of 1954, the total number of visits to the department was 805.

In March of this year, the sixteen orthoptists now residing in British Columbia joined forces to form the first Canadian orthoptic organization, this to be known as the Canadian Orthoptic Association of British Columbia. The aims of the Association are first, to become nationalized; second, to encourage and facilitate research and to arrange for the presentation of scientific papers followed by discussions for the benefit of those who are unable to travel great distances to attend conventions or refresher courses; and third, to become affiliated with the British and American orthoptic societies.

SOME REMARKS ON DIVERGENT STRABISMUS

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THE cases of divergent strabismus that we all see present an interesting group for discussion. This is particularly so since the cause of the condition is poorly understood and the treatment is not altogether satisfactory. The orthoptic technician is interested in this group as her opinion is commonly sought relative to any help that she may offer these patients. There are many arbitrary ways of classifying these cases, but for the sake of simplicity I shall divide them into merely two groups: first, cases of intermittent exotropia, and second, cases of constant exotropia. The chief reason for dividing them in this fashion is that the treatment for the groups is quite different.

INTERMITTENT EXOTROPIA

The cases of intermittent exotropia are of most interest to the orthropic technician. Authorities have put forth fairly straightforward rules for the treatment of this group of strabismus patients. On paper these rules are quite simple; however, they are not always applicable in all cases. Both Scobee and Costenbader stated that if the exotropia is 18 or 20 prism diopters or more, the cases should be considered surgical and an operation should be performed on the extraocular muscles. The patients with exotropia or exophoria of less than this amount should be treated by orthoptic methods. In actual practice, however, these rules do not always work out quite so simply. Parents frequently object to what they consider a major operation on the eyes when only a relatively minor disfigurement exists. Again, the parents would like a guarantee that an operation, if undertaken, will completely cure the defect.

With these commonly encountered difficulties taken into account, one must formulate a plan of treatment. There are two main approaches in treatment: first, prevention or treatment of the convergence insufficiently which will always develop in these cases if the condition is untreated, and second, correction of the existing deviation, which is almost always more marked with fixation at a distance. These two approaches in treatment are put in the order given because often only the first can be accomplished. If for any reason the deviation cannot be corrected surgically, one must be satisfied with helping the patient by treatment aimed at the prevention and control of convergence insufficiendy. Such treatment not only will prevent or control symptoms from convergence insufficiency but also may hold stationary the exophoria that exists at distant fixation. Without treatment directed along this line, the exophoria at distance would likely increase.

This group of cases is rather unusual among the disorders of binocular vision. "Exophoria-tropia," "periodic divergent strabismus," "divergence excess type of exotropia" and "daydreaming exotropia" are just a few of the terms that have been applied in the past. Some of the features which make the group unique are the rather late age at onset, the tendency to progression with age, the infrequency of amblyopia and the relatively good convergence present in most of the cases.

The history frequently is all that is necessary to make the diagnosis. It is noted that

From the Section of Ophthalmology, Mayo Clinic and Mayo Foundation.
The Mayo Foundation is a part of the Graduate School of the University of Minnesota.
Read at the meeting of the Mid-Western Section of the American Association of Orthoptic Technicians, May 5, 1954, Rochester, Minnesota.

one of the child's eyes "wanders out" at times, especially when he is tired or inattentive. Some children close one eye when outdoors. When examined, vision usually is normal in each eye, unaided or with corrective lenses. The eyes generally appear straight, both when looking at 20 feet and when looking at 13 inches. The cover test reveals a large exophoria, usually greater at distant fixation than at near, and often there is spontaneous diplopia or failure to regain parallelism after the cover test at 20 feet. Older children and young adults frequently have asthenopic symptoms at near. Prolonged reading is done with effort and often causes bitemporal headache and pain in the eyes which subside rapidly after the close work is discontinued.

The near point of convergence very often is normal, as is the prism convergence, and the prism divergence usually is excessive (more than 8 prism diopters). Ductions and versions are normal. When it is stated that prism convergence is normal, it must be remembered that the starting position is considered as beginning at the exophoric position. Thus, if a person with an exophoria of 15 prism diopters overcomes prism base out equal to 15 prism diopters, he has a prism convergence of 30 prism diopters. It is true that the older the patient the more likely he is to have some degrees of convergence insufficiency, but probably his intermittent exotropia is of longer standing and the usual compensatory mechanism for the establishment of concomitancy has had more effect than in the younger patient. The same compensatory mechanism is seen to act throughout the phorias and tropias.

The mention of an excessive prism divergence usually is enough to bring forth the argument as to whether or not there is an active divergence mechanism. This is not the place nor have we the time to enter the argument here. If divergence is only a passive relaxation of convergence, then it probably represents the only associated striated-muscle function that is without two active antagonists.

There appears to be evolving a certain awareness that surgical treatment in cases of exotropia should be on an all-or-none basis. Partial correction usually leads to gradual lessening of the correction obtained, and further partial correction still fails to achieve parallelism. One seemingly logical explanation is that in these cases fusion usually is present, at least for near objects, suppression is alternating, anomalous localization is fairly infrequent and not deep-seated, and progression is the rule with age. If surgical correction falls short of producing parallelism at distant fixation, the above factors are not much altered, while if, postoperatively, the eyes are straight or a bit overcorrected, the alternate suppression is abolished, as is usually the anomalous localization. Fusion is stimulated, and when age tends to aggravate the condition, these factors are strongly established and prevent the lapse into exotropia.

In esotropia, undercorrection is to be preferred if parallelism is not achieved, and as the patient grows older, the residual deviation commonly will lessen. Here time is on the physician's side, while in exotropia such is not the case.

There is variance of opinion on the value of nonsurgical treatment of this group also. Scobee dogmatically states that 18 prism diopters is the dividing line, and that exophoria of less than this amount should be treated by orthoptic methods and that more than this amount is indication for surgical treatment. Costenbader is in close agreement here, stating that patients with more than 20 prism diopters of exophoria almost always will need surgical assistance. He says that preoperative orthoptic training is to be desired in order to break up suppression and create diplopia, while Scobee and Burian say that preoperative orthoptic training is unnecessary.

There is little disagreement that orthoptic training is the treatment of choice for the convergence insufficiency often present in these cases, and probably always present

if treatment is sought late. Convergence exercises with base-out prisms, finger-to-nose exercises, and stereoscopic slides are all beneficial. Prangen stated that he had seen numbers of patients who did not progress in the amount of exotropia while they faithfully followed convergence exercise.

I do not wish to be boresome with case reports or tabulations of figures but merely wish to point out that my colleagues and I believe we have obtained better results in the treatment of these patients who have intermittent exotropia of the divergence excess type by simultaneous bilateral surgical procedures directed at the external recti than by former methods which consisted of unilateral recession of the external rectus or recession and resection confined to one eye. In spite of the fact that many of these disturbances are mainly phorias and only occasionally tropias, a little surgical treatment is not enough. Probably more often it would be desirable to add a resection of one internal rectus to the bilateral recession of the external recti.

In the past, many of these patients went untreated until they reached their teens, when the cosmetic deformity became apparent to them. By then the alternate suppression was much more deep-seated; the deviation was greater and the condition was definitely less easily corrected. Certainly, an effort should be made to treat these patients earlier by proper surgical means. The achievement of proper adjustment of the binocular mechanism in these cases is just as important as in the cross-eyed child.

CONSTANT DIVERGENT STRABISMUS

The cases of constant exotropia are of much less interest to orthoptic technicians, because, in my opinion, the treatment falls under the heading of cosmetic muscle surgery. We may subdivide this group on the basis of apparent cause, but actually the treatment varies little. In the first category are the cases of alternating divergent strabismus which may arise spontaneously in childhood or may progress from a previous intermittent exotropia. Some fusional range can often be demonstrated on the major amblyoscope at the angle of strabismus. In this group, if the eyes are placed in a parallel position surgically, there is a possibility of developing normal binocularism. In deviations up to 35 prism diopters, the usual treatment is a maximal recession of the external rectus plus a resection of the internal rectus of the nondominant eye. Deviations of greater than this amount require surgical treatment of three or four muscles.

The next category of cases of divergent strabismus consists of those in which the condition is secondary to poor vision in one eye. This category contains a large number of persons and poses difficult problems of treatment. The poor vision may be due to injury or to the development of cataract or some other intraocular disorder in one eye. This category also includes patients who originally suffered from untreated convergent strabismus in childhood, with amblyopia ex anopsia. As we know, certain of these patients develop divergent strabismus in adulthood. Treatment is usually limited to maximal surgical procedures confined to the squinting eye in an effort to alleviate the cosmetic defect.

The final category of cases of divergent strabismus which I wish to mention consists of those which occur secondarily to operations for esotropia. Certainly the number of these cases has lessened materially since the days when free tenotomy of the internal recti was performed. Some surgeons, however, still use this procedure. Another reason why these cases are still seen in some number is probably the fact that bilateral recession was commonly employed in the not too distant past. It seems that an overzealous attempt to correct all esotropia at a very early age was an important factor in the number of cases of overcorrected esotropia in children. The divergent strabismus in these children frequently may not show up for two or more

years after their operations and it is most difficult to treat, as the mechanism seems to be no different from those in other cases of divergent strabismus.

Occasionally one has the opportunity to view the development of the last-mentioned type of divergent strabismus following an operation for esotropia. The condition may follow a simple recession-resection operation and the usual mechanism is likely a slippage or untieing of the recession sutures which allows the internal rectus to fall away from its attachment to the sclera before scar tissue has developed and anchored it firmly in place. Suture material swells and untied sutures are seen quite commonly; also, eyes are kept bandaged for a shorter time and motility is allowed to occur in the operated eye earlier than in years gone by.

The behavior of divergent strabismus that follows an operation for esotropia is one of the most interesting phenomena in the study of binocular muscle imbalance. When one sees a patient who has this type of divergent strabismus and with a history of a recent operation for crossed eyes, one assumes that a poor operation was done and that it has resulted in what appears to be a paretic internal rectus muscle. One assumes further that either a free tenotomy was performed or that a recession was performed and the sutures slipped. Acting on this assumption, one would think that simply placing the internal rectus where it belongs would cure the condition, but anyone who has tried this procedure will tell you that it does not work. Commonly, it is necessary not only to change the position of the internal rectus but also to do a resection of the internal rectus and perhaps a recession of the external rectus in order to get the eye into parallel position.

If the esotropia operation that preceded the divergent strabismus has been done some time ago, one is tempted to postulate that long-standing divergence is responsible for the difficulty of correction, but when the surgeon sees the condition develop under his very eyes, the mystery deepens. He realizes that a good operation has been performed and he is commonly tempted to place the internal rectus where it should have been placed, but in everyone's experience that I have known of this has resulted in disappointment. Even though the eye has been reoperated on as soon as practical with repair of the slipped tendon, and even with lessening of the effective recession, the eyes will not come out of the divergent position. Commonly, even bringing the internal rectus back to its original position or advancing it past its original attachment will undercorrect the overcorrection. The question as to what takes place in the neurosensory mechanism remains unanswered, but it certainly leads to interesting speculation for those concerned with the physiology of binocular vision.

ADAPTATION TO VERTICAL PRISMS

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HYPERPHORIA and vertical prism vergence interest orthoptic technicians because they affect the comfort of the patient. Indeed, symptoms are often relieved by the proper prism correction of a vertical imbalance.

As is well known, the vertical prism vergences of most persons are 2.5 to 3 prism diopters; these are thought to be fixed limits. The vertical amplitude is often used as the basis for correcting hyperphoria with prisms.

In a study made at the Mayo Clinic by Ogle and Prangen,[1] it has been shown that the eyes of most persons can compensate to much larger degrees of vertical divergence than that usually believed possible. When vertical prisms are placed before the eyes, adaptation takes place and the range of vertical divergence is increased; the vertical prism vergences are found to remain normal; and frequently, the original hyperphoria is maintained. A certain group of patients with concomitant hyperphorias, however, do not have such marked compensation. This study, for which I did the testing, forms the basis for these remarks.

In this study of the effect of prisms on the vertical divergence, the fixation disparity technique was used.[2] By this method a measurement of the vertical motor imbalance is obtained while fusion is maintained and each eye has essentially the same visual task. In the ordinary Maddox rod tests, fusion is prevented and frequently hyperphoria is magnified by lateral phoria, especially when the lateral phoria is large. This effect is eliminated by the fixation disparity technique because lateral deviation is prevented by fusion.

If prisms were worn before the eyes to force vertical divergence, one would expect the typical fixation disparity curve to be displaced an amount corresponding to the power of the prism worn. This assumption was found to be untrue. The fixation disparity curve found when the patient had worn prisms of 2 diopters in clip-ons for 2 hours, and was continuing to wear them, was the same as that obtained before the prisms were worn. The same results were found when the patient had worn vertical prisms of 6 diopters for 2 hours, and was still wearing them, if the prisms had been introduced in steps of 2 diopters each. In these cases the eyes had completely compensated for the deviation caused by the prisms. This is certainly a greater compensation for vertical divergence than has been believed possible. Would not this fact give us some idea as to why some patients with a large amount of hyperphoria have no ocular complaints?

Compensation to vertical prisms actually takes place rapidly. When the prisms were used in steps of 2 diopters each time, the time required for compensation in 7 subjects varied from three to ten minutes, but the greater part of the compensation occurred in the first few minutes. When the fit-over prisms of 6 diopters were removed, diplopia occurred and usually lasted for a period of two to sixteen minutes. Differences in the rate of recovery from patient to patient sometimes seemed to depend on whether there was a left hyperdeviation or a right hyperdeviation, perhaps indicating a natural tendency of the subject to hyper-

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Read at the meeting of the Mid-Western Section of the American Association of Orthoptic Technicians, May 3, 1954, Rochester, Minnesota.

phoria. The rate of recovery also depended on the length of time that the 6 diopter prisms had been worn. The rate of recovery from wearing prisms that force a vertical divergence was much slower if single binocular vision was prevented during the period of recovery. In the absence of stimuli for fusion, the hyperphoria had not returned to normal even after 2.5 hours.

Of the 7 patients who wore prisms up to 6 diopters, 5 experienced no particular ocular discomfort. All commented that objects in space appeared queer, but this could be due to the optical distortion by the prisms rather than to the vertical divergence.

If such compensation is a normal physiologic process, why cannot patients then compensate for their own vertical phorias? Study of the effect of prisms on subjects who have hyperphoria disclosed that the phoria of some patients was essentially corrected by the wearing of a prismatic correction. For many subjects, however, the hyperphoria was only partially reduced by the wearing of a prismatic correction. For still others, the vertical prisms did not correct the hyperphoria in the least, that is, the original hyperphoria persisted in spite of the vertical prisms.

Underlying these compensatory phenomena is the compulsion-to-fusion reflex, which strives to maintain similar images on corresponding retinal points. On the basis of this study there appear to be two types of involuntary compensatory reflexes. The first pertains to the rapid adaptive vertical divergent movements of the eyes as found in the clinical test for vertical prism vergences. In this test, the prismatic deviation is introduced rapidly and rather definite end points are found beyond which diplopia exists. During this test the eyes tend to lag slightly behind the power of the vertical prisms used—the lag being greater, the greater the vertical divergence. This lag is measured by the fixation disparity test. Hence, the fixation disparity test measures the hyperphoria during this rapid phase of adaptation during which fusion is maintained.

The second type of involuntary compensatory reflex is slower. The eyes slowly but completely compensate for vertical prism divergences, and when so adapted to the prisms that force a vertical divergence, all future eye movements are made relative to these new positions, which become the natural ones. The normal fusional amplitudes measured clinically represent only the maximal divergences within which the slow stabilizing compensatory mechanism can begin to operate.

The normal binocular activity of the eyes, so far as vertical movements are concerned, is maintained by the adaptive mechanisms that maintain a consistent coordination of the eyes in spite of geometric differences or artificial obstacles such as anisometropic refractive corrections or vertical prisms.

The circumstances under which compensation can be made to imposed vertical prisms may be quite different from those under which compensation might be expected to a hyperphoria caused by some motor obstacle or an innervational anomaly to the muscles. When prisms are placed before the eyes, only the fusion mechanism is essentially involved. If the original hyperphoria remains after prism correction has been worn for that hyperphoria, the deviation must be due either to a permanent mechanical anomaly or to a persistent unequal degree of innervation to the ocular muscles involved in the vertical divergence. These innervations persist in spite of stimuli for vertical divergence corrective movements. If the hyperphoria is innervational, it is as though there were two centers for the control of vertical divergences, the one controlling the slow compensatory mechanism and the other controlling the rapid compensatory mechanism. The innervational difference of the hyperphoria would affect only the rapid compensatory mechanism.

SUMMARY

The results of this study, conducted at the Mayo Clinic, can be summarized as follows:

1. In clinical tests, vertical prism vergences are obtained relatively quickly and the limiting prism divergence of about 3 diopters is usually found.

2. The majority of subjects, whether they have hyperphoria or not, seem to have the ability to compensate after several minutes for vertical divergences that are introduced by prisms exceeding 6 diopters. But these larger degrees of vertical divergences caused by prisms can be compensated for only when prisms of 2 diopters or less are introduced at one time.

3. The hyperphoria measured on these subjects when the vertical divergences have been compensated for is usually the same as was the original hyperphoria, measured before the prisms were placed before the eyes.

4. For many subjects, the eyes are able to compensate immediately for the vertical prismatic deviations produced by anisometropic refractive corrections. This compensation must be a constantly changing one, too, because the prismatic differences vary with the direction of gaze of the eyes.

5. There are, however, persons with hyperphoria who are unable to compensate for vertical prisms. These patients will accept and maintain the prisms prescribed, and their hyperphorias will be reduced in proportion to the prisms worn. Therefore, the effective hyperphoria of these persons can be corrected by prisms.

The ability of the eyes to compensate for vertical prisms is an important fact. It was hoped that in this study it would be possible to distinguish at the time of examination between those persons who would and those who would not respond to prisms and between those whose subjective symptoms of ocular discomfort were or were not truly due to hyperphoria. At present we have recourse only to the generally accepted method of trying prisms in clip-overs to learn whether or not the patient's symptoms are relieved by the correction of vertical phoria.

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THE SELECTION OF ORTHOPTIC CASES

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THERE are two general questions in the selection of orthoptic cases: (1) How will the patient benefit by developing fusion habits? (2) Will the benefits gained be rewarding enough for the effort this patient will have to make? This second consideration can apply to the technician as well as the patient if we consider the time and effort which the orthoptist may spend on a case without achieving improvement.

Nature has supplied us with only a few reflexes as tools for fusion, not with a complete flawless mechanism. We must keep in mind that fusion is not a highly important human visual function. We know this from patients who have gained fusion, later lost it, and have never become aware of their loss of fusion or suffered any symptoms from this loss.

The one important thing, however, is single vision, regardless of how it is obtained — whether binocularly by fusion or monocularly by suppression or amblyopia ex anopsia.

It is true that fusion is the preferred visual function for these three reasons:

1. *Better vision.*

With fusion, good vision is maintained in both eyes, with appreciation of stereopsis and a normal visual field. (This might be called an occupational reason.)

2. *Cosmetic considerations.*

(These might be primarily psychological.)

3. *Comfort.*

(This could be classed as a medical reason.)

Before determining whether or not a patient has a good orthoptic prognosis, it is well to consider four aspects of the case: binocular status, comfort, recognition of error, and attitude of patient.

Binocular Status

Under binocular status there are a number of things to take into consideration, such as the age at onset of the strabismus, whether the squint is alternating or monocular, and whether there is a paretic element.

If the squint is alternating, the matter of creating binocular awareness is the primary problem, and should there be no latent fusion, the prognosis is usually very poor.

If the squint is monocular, the age at onset and the patient's present age (or duration of squint) will influence the status of visual acuity and the prognosis. For instance, a patient with esotropia established before the age of two and who is seen after the age of six probably has very low visual acuity and poor fusion possibilities. It is very difficult to fuse one poor image with one good image. It is easier to fuse two poor images. So it is evident that equal or nearly equal binocular vision is of great importance in the selection of these cases.

The size of the deviation should be taken into consideration when orthoptics is under advisement, especially if no surgery is planned. In my experience more than 20 prism diopters of esotropia is usually too much for correction by orthoptics without surgery, unless the esotropia is accommodative.

Other factors in binocular status are the versions, which must show an absence of paresis if a patient is to maintain fusion with all binocular movements.

Read at the meeting of the Mid-Western Section of the American Association of Orthoptic Technicians, May 4, 1954, Rochester, Minnesota.

Comfort

The next consideration in the selection of orthoptic cases is comfort. Is the patient going to have distressing symptoms once you begin orthoptic treatment? Treatment of patients with heterophoria will depend upon the symptoms which are present. If adjustment is good, generally no treatment is advised because of the possibility of bringing about an asthenopia which was not present previous to fusion training. This mistake might very easily be made with an adult patient who has a long established suppression or with patients who have a large refractive difference between the two eyes (anisometropia). If the condition causes distress, the patient will find it worth his while to attempt to overcome his discomfort and enjoy comfortable binocular vision; if he is symptom-free, orthoptic training may result in discomfort.

These cases require a careful refraction and a general health examination. The selection for training of patients with heterophorias can sometimes be very difficult. The fact that the patient fuses part of the time would appear to make his problem an easy one to correct, but this is not always the case. The patient may be fusing to his limits already, and it may not be possible to increase those limits. Surgery may be necessary for complete relief of symptoms; however, the determination of the amount of deviation which the patient can control may be a factor in the surgical plan of the ophthalmologist.

Suppression is generally a chief problem in heterophorias. Sometimes breaking this down is all that is necessary to establish good fusion habits. If suppression remains, the patient cannot increase his amplitudes properly.

Patients with esophoria need abundant amplitudes in the direction of divergence as well as convergence, with skill in speedy vergence changes, to overcome their discomfort.

Patients with exophoria usually have suppression, but they may experience fusion at near with accommodation and may have a good near point of convergence. These patients are aided by a breakdown of suppression and by learning recognition of diplopia in order to control their deviation. However, they frequently find it necessary to resume their convergence exercises from time to time in order to avoid a relapse.

Vertical phorias may improve by increasing the horizontal fusional amplitudes. If there is a combination of lateral and vertical deviation—and there frequently is, a correction of the lateral deviation will often permit fusion to control the vertical deviation.

Patients with convergence insufficiency may have basically either an esophoria or an exophoria, and they should be given voluntary and accommodative convergence exercises. They comprise a group very satisfied with the relief that orthoptics can give them.

The adjustment of presbyopes to the wearing of bifocals comfortably is another helpful service of orthoptics.

The importance of the treatment of heterophorias cannot be too highly stressed, since patients in this group suffer a greater amount of discomfort than persons with other types of ocular muscle imbalance.

Heterotropic patients are, as a group, not especially symtomatic or uncomfortable, at least not until the stage at which the heterotropia has been converted to a heterophoria. At this point, asthenopia is a necessary evil in the patient's improvement. However, in heterotropias, orthoptic treatment is largely empirical, except in accommodative heterotropias, which are ideal orthoptic cases. Among patients with heterotropia, we frequently see those who have such a low degree of squint that a surgeon hesitates to perform an operation and prefers to attempt orthoptic correction. Patients in this group can sometimes learn how to fuse and how to control their de-

viation, but prognosis is generally poor. In this group more than in any other, it is only by working with the patient that a definite answer regarding his ability to fuse and to overcome his deviation can be obtained.

Innervational squints require much the same kind of approach, since the deviation is highly variable.

Another category of squints is the combination group: one portion of the squint being a surgical problem, the other portion an orthoptic problem. Opthalmologists frequently prefer that the orthoptic correction should precede the surgical correction, since less extensive surgery may then be required and better postoperative results will be assured.

This leads to a discussion of orthoptic treatment in conjunction with surgery. Some surgeons prefer that orthoptists help in correcting amblyopia ex anopsia, developing binocular fixation, developing vergence control, correcting abnormal retinal correspondence, and breaking down suppression before surgery is done. Other surgeons prefer orthoptic treatment after surgery is done, and others advise treatment before and after surgical operations to complete the fusion control which the surgeon has begun by correcting the position of the eyes.

Special mention should be made of adults with heterotropia. Selection of these patients for orthoptics requires particular caution. One can generally expect to get very good cooperation from adults, but it must be remembered that any anomaly which they have is undoubtedly deep-seated. Suppression, for instance, is very difficult to break down in an adult, but by the same token, an adult who has diplopia does not easily suppress. Orthoptics can be helpful to the adult who is annoyed postoperatively by diplopia although he has a good surgical result. On the other hand, orthoptics usually produces very little improvement in an adult with heterotropia, and may even produce discomfort.

Recognition of Errors

The third consideration in the selection of the orthoptic patient is his ability to recognize errors. In this regard, the recognition of diplopia is the most important step to binocular vision. There are a few lesser aids in the control of the eyes, such as recognition of loss of visual field, of stereopsis, and of the blurring of vision, but these are limited in their application. Without such recognition, there is no sensation of "wrong" adjustment when the patient does not fuse, and there is no sensation of "success" when the patient fuses for the first time. It is through his intelligence and observation of what he sees that the patient learns binocular skill. If a patient is too young or retarded, chances for succesful orthoptic treatment are very poor.

Attitude of Patient

The attitude of the patient toward his binocular situation is another consideration. This involves the parents' cooperation in the office as well as at home and their willingness to carry out specific instructions. Some adult patients have an attitude of not wanting to be helped, and they would rather you didn't investigate their eye condition. Such a person may have deep-seated psychological scars which are only aggravated when you annoy him with treatment.

What should one do when an unsuitable patient is referred for orthoptics? We are all aware of the harm which can be done to our professional standards when orthoptic training is given indiscriminately. The harm is done not only to ourselves individually but to the orthoptic group as a whole. When an unsuitable patient is referred for orthoptics, the orthoptist should give a frank report to the referring ophthalmologist. This is necessary if he is to have confidence in the orthoptist. In my experience, patients are referred for "orthoptic treatment" when the referring doctor really means, "If this is an orthoptic case, the patient is to have orthoptic training."

He also means that I am to sift out the unsuitable cases from the orthoptic cases or the partially orthoptic cases.

Finally, if you are not sure about a case, simply explain that you have not yet collected sufficient evidence and would like to see the patient again to confirm your findings. The ophthalmologist will appreciate your frankness and sincerity.

No part of orthoptics requires more skill than the discriminating selection of cases for intensive orthoptic training.

AN EASY METHOD OF MAKING SECOND DEGREE FUSION SLIDES FOR ORTHOPTICS

ROBERT J. SCHILLINGER, M.D.
LOS ANGELES, CALIFORNIA

FIRST-DEGREE and third-degree orthoptic slides require a certain amount of skill and ability in their preparation, and one may have to resort to photography for the realistic achievement of depth perception. The method of preparing these slides has been described in detail by Allen[1]. However, it is in the training of vergences that perhaps the greatest variety is required, and a method is hereby presented which enables one to make easily any number of slides for this purpose. This method can also be used to make certain parts of first-degree fusion slides.

Method: The objects used are made from decalcomania figures (transfers) obtainable at variety stores. Animals, storybook figures, etc., which are small enough are purchased in duplicate, and from each picture one element is removed so that a composite image will be seen binocularly. For example, the illustration shows the head of a horse, and each slide shows only one ear, in one the right ear, in the other the left (fig.1). These figures are transferred to 3¼ by 4 inch slides of glass or lucite, the latter being preferable since it is unbreakable. The decalcomanias can be moved for five to ten minutes before they are dry, and this makes it easy to align them by holding one slide in front of the other. Final adjustments are made after viewing them through the troposcope.

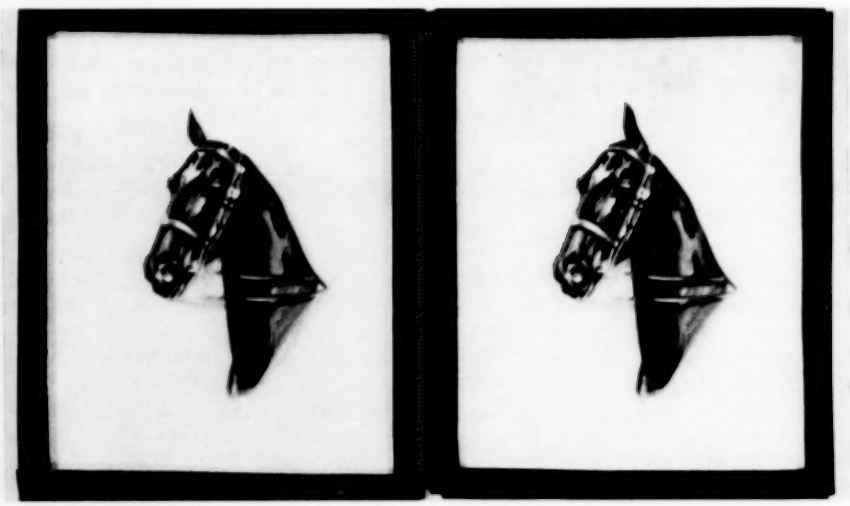

FIGURE 1

From the Department of Ophthalmology, College of Medical Evangelists.

*Reproductions accompanying this article, through the courtesy of the Meyercord Company, Chicago.

REFERENCE

1. Allen, Lee: How to make your own orthoptic slides, Am. Orthoptic J., 3:34-42, 1953.

AMERICAN ORTHOPTIC JOURNAL

Published Annually as a Supplement to the Transactions of the American Academy of Ophthalmology and Otolaryngology

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Editorials

TRAINING THE ORTHOPTIC TECHNICIAN

Some years ago, within the easy memory of most of us, the training of orthoptic technicians was quite "unorganized and varied." It is a surprising fact that many candidates for the American Orthoptic Council examinations could qualify, though entirely possible that they might have real trouble with the examinations presently offered.

Such training as was available was solely at the discretion of the few offices and clinics which would accept "apprentices," and frequently it was selfishly motivated by the need for more orthoptic assistance. The American Orthoptic Council offered a few suggestions and set certain minimal requirements for candidates for examination.

From that time, training the orthoptic technician has gone on apace. In 1947, the secretary of the American Orthoptic Council was authorized to prepare a syllabus for instruction, and with the help of certain Council members and others interested in orthoptics, this was done. It has since become cumbersome and not fully applicable to our current needs.

In 1948, under the guidance of Dr. Walter B. Lancaster, the first intensive course in basic orthoptics was organized. For two months that summer in Maine, using patients and equipment transported from Boston and teaching talent from various parts of the United States, 28 student technicians were lectured, drilled and quizzed. And from this laborious beginning, the now well-established summer course has moved to Boston, St. Louis, and Iowa City. Each change of location has brought about changes and advances in teaching techniques and material.

Lest any should feel (as was at first misconceived) that several weeks of textbook study and demonstrations is considered adequate training in orthoptics, the American Orthoptic Council constantly emphasized that an additional seven months of practical training under a certified technician was required. More recently, this has been increased to a total training of twelve months.

In addition to the Council's course in orthoptics, several clinics and institutions offer total training (didactic and practical), and two such courses lead to academic degrees. Thus a variety of training is available to the prospective student in orthoptics.

During the last two or three years, the need for greater uniformity in teaching and the necessity of providing teaching manuals and texts have become increasingly evident. Under the able guidance of its Chairman on Instruction, Dr. Hermann Burian, voluminous lecture notes have been provided students of the Council's course. From this, with proper additions and revisions, a syllabus will grow, and if time permits, even a standard textbook for instruction in orthoptics will come to print.

Thus the training of orthoptic technicians grows. The courses are of higher quality, the instruction material is better, and the supervision of practical training is more adequate. The orthoptic technicians of tomorrow will know more than the orthoptic technicians of today or yesterday, just as tomorrow's ophthalmologists will know more than today's.

FRANK D. COSTENBADER, M.D.

OCCLUSION IN STRABISMUS

The purposes of occlusion are well known, but, there are two common misconceptions regarding its use. The first is that prolonged occlusion will bring out the full extent of the deviation of an intermittent exotropia. On the contrary, with the reduction of suppression by occlusion the binocular status may often improve, making dissociation of the eyes more difficult. The measured deviation may actually be less because of a greater desire for fusion. This improvement appears to be a temporary one unless further treatment is carried out.

The other misconception regarding occlusion concerns the so-called "intermittent esotropia" with amblyopia. Often occlusion is not prescribed lest it may disrupt peripheral fusion, producing a manifest deviation. Actually, many of these cases are due to a small tropia with marked central suppression, with the bulk of the deviation kept latent by peripheral fusion. Frequently this type of case responds well to occlusion, for as visual acuity improves and suppression decreases, the ability of fusion to control the deviation increases rather than fails. Therefore, when occlusion is indicated for the passive treatment of suppression or the elimination of amblyopia, fear of producing a manifest deviation should not cause one to hesitate before occluding.

NANCY M. CAPOBIANCO

ORTHOPTICS FOR THE ADULT PATIENT

Although it is usually stated that it is the task of orthoptics to give to the patient comfortable single binocular vision, there exists a widespread misconception that the sole aim of orthoptics is to straighten crossed eyes by exercises.

This misconception, while understandable, is doubly unfair to orthoptics in that it sets to it a primary task which it can only rarely achieve by itself, and at the same time restricts it to that task. It is unfair to the many patients who might greatly benefit by orthoptic treatment, but to whom such treatment is not suggested,

and it is unfair to the ophthalmologist, who could make much better use of his orthoptic set-up by realizing all its potentialities.

The alert ophthalmologist will find that there is in every routine practice a surprisingly large number of patients with convergence insufficiency and minor heterophorias, who are not severely handicapped by their symptoms but who could be made to function much more comfortably and efficiently if they were given a few sessions of training. These patients should have just as much attention paid to their neuromuscular condition as to their astigmatism, and the ophthalmologist will find that the time of his orthoptic technician left free by her other tasks will be more than taken up by these patients.

I can not urge strongly enough that this neglected aspect of orthoptic training be more carefully considered both by ophthalmologists and by orthoptic technicians.

HERMANN M. BURIAN, M.D.

ANNUAL MEETING OF THE AMERICAN ORTHOPTIC COUNCIL

The annual meeting of the American Orthoptic Council was held in New York City in September at the time of the meetings of the American Academy of Ophthalmology and Otolaryngology.

Prior to the meeting, the annual examinations leading to certification of orthoptic technicians were conducted at the Eye Institute in New York. There were twenty-eight candidates, of which twenty-four were successful and have been certified by the Council as proficient in orthoptics.

At the annual meeting of the Council there were several items discussed and actions taken which are of general interest to readers of the American Orthoptic Journal.

During 1954, the Delta Gamma Fraternity awarded three scholarships to orthoptic students. The Council is most appreciative of this project of Delta Gamma and of the help they have given. Since 1948, Delta Gamma has granted assistance to twenty-seven orthoptic students.

At its meeting in 1953, the Council took the following action and reaffirmed it in 1954, to be effective for all technicians who are certified in 1955 or after. It urges that all technicians who were certified before that date conform as nearly as possible, but it does not make conformation mandatory. Requirements for technicians certified in 1955 and thereafter are as follows (there are three alternatives):

1. The technician is employed in a single ophthalmic office on a salaried basis.
2. The technician is employed by a specified group of ophthalmologists from whom she receives cases and to each of whom she reports. The bills for services should be sent by the group, or by each member of the group to his own patients, and the technician shall be paid a salary.
3. The technician may be similarly employed by a hospital or clinic, the bills for services to be sent by the employer, and the technician to be compensated by salary.

It should be pointed out that this action taken by the Council is for the protection of the orthoptic technician and for the best possible relationship between technicians and ophthalmologists, as well as for the best possible management of the patient.

The Council has, for some time, wished to raise the requirements for certification. It has now changed the regulations so that

beginning with the examinations in 1956, an applicant shall be 20 years of age, shall have two years of college or its equivalent, and shall have a total of one full calendar year of orthoptic training. This is particularly called to the attention of those clinics and offices which train prospective orthoptic technicians.

DOROTHY R. BAIR
Secretary to the Council

ANNUAL MEETING OF THE AMERICAN ASSOCIATION OF ORTHOPTIC TECHNICIANS

The Thirteenth Annual Meeting of the American Association of Orthoptic Technicians was held at the Waldorf-Astoria Hotel in New York City in September 1954.

The topic of the symposium was "Orthoptics and Muscle Surgery" and was arranged by the American Orthoptic Council. The speakers were Dr. Edmond L. Cooper, Nancy M. Capobianco, Dr. J. Ringland Anderson of Melbourne, Australia, and Lorna Billinghurst of Cambridge, England.

In conjunction with the symposium, the exhibit committee of the American Association of Orthoptic Technicians chose as its subject, "Comparative Study of Binocular Vision in Surgical Cases With and Without Orthoptic Treatment." Those who contributed statistics were Dr. G. H. Jonkers of Gorinchem, Netherlands, Dr. Moacyr E. Alvaro of Sao Paulo, Brazil, Dr. T. Keith Lyle of London, England, Dr. Conrad Berens, Dr. Alfred Elliot, Lucille Sobacke and Dr. Edmond L. Cooper.

Instruction courses were held again this year in the morning, and in the afternoon papers were read by Dr. Hermann M. Burian, Dr. G. H. Jonkers of Gorinchem, Netherlands, Dr. Moacyr E. Alvaro of Sao Paulo, Brazil, Dr. Jules Francois of Ghent, Belgium, Julia Lancaster, Anita Stelzer, Mary Kramer, Frances Walraven, and Lorna Billinghurst of Cambridge, England.

At the business meeting we were pleased to announce that Dr. William Benedict had been made our first honorary member and that Elsie Laughlin had been appointed the new associate member of the American Orthoptic Council. The Lancaster Award, given each year to a member of the American Association of Orthoptic Technicians for meritorious work, outstanding leadership, teaching, writing or research in orthoptics, was received by Elizabeth Stark.

The locations for the 1955 Regional Meetings were announced and are as follows:

Southern ..... Tampa, Fla.
Chairman, E. Christ
Eastern ..... Philadelphia, Pa.
Chairman, Mary Sharpe
Western ..... Vancouver, B. C.
Chairman, Catherine Lunn
Midwestern ..... Milwaukee, Wis.
Chairman, Dolores Engel

SECTIONAL MEETINGS OF THE AMERICAN ASSOCIATION OF ORTHOPTIC TECHNICIANS Held in 1954

The Sections of the American Association of Orthoptic Technicians displayed a gratifying activity during 1954. All Sections held well-attended regional meetings and presented excellent programs.

The following are the reports from these meetings, as submitted by the Secretaries of the Sections:

Eastern Section: Washington, D. C.
March 15 and 16, 1954
Maria Borzillo,
Chairman

The first paper "Some Aspects of Accommodative Strabismus," was given by Marshall M. Parks, M.D., of Washington, D. C. Doctor Parks explained some of the causes of accommodative strabismus, how to diagnose the cases and classify them according to cause, and how to treat these cases. He showed very clearly the difference between normal and abnormal accom-

modative-convergence ratio and how to diagnose this. The use of DFP and some results of its use were also discussed.

Dorothy Stobie of Buffalo, N. Y., talked on "Consideration of Treatment in Abnormal Retinal Correspondence." Miss Stobie discussed her method of treating ARC and some of the results of her treatment.

"The Management of Cyclo-Vertical Deviations" was discussed by William C. Owens, M.D., of Johns Hopkins and Walter Reed hospitals. He gave a very concise, step-by-step plan of how to diagnose the cause of vertical imbalances.

Nancy Capobianco of New York City discussed "Evaluation of Some Phases of Orthoptics." Miss Capobianco evaluated results in her treatment cases and gave reasons for her failures which could apply to many cases of unsuccessful treatment.

On Tuesday, Dorothy Bair demonstrated simple and accurate ways to make stereoscope and troposcope slides. Aleatha Tibbs discussed the Walraven separator as used with accommodative strabismus. Louisa Kramer explained the principles of the stereoscope and how it may aid greatly in orthoptic treatment.

Dr. Frank Costenbader examined several of his patients for our benefit, explaining what he was doing, what he expected to learn from his findings, and the probable treatment and prognosis of the cases.

Mr. Jim Robinson of the American Optical Company was with us to answer our questions and take suggestions about the AO instruments which we use.

There were 26 members and 3 students present at the meeting.

The 1955 meeting will be held in Philadelphia.

Southern Section: Florence, S. C.
April 26 and 27, 1954
Marguerite Worsham,
Chairman

The Southern Section of the American Association of Orthoptic Technicians held its sixth regional meeting on April 26 and 27 at the Colonial Hotel in Florence, South Carolina. Marguerite Worsham, chairman of the Section, presided, and Mary Virginia Stallworth served as secretary.

On Monday morning, Dr. Marshall M. Parks of Washington, D. C., gave a paper on "Some Practical Aspects of Accommodative-Convergence." Dr. Howard Stokes of Florence, S. C., spoke on "Etiology of Strabismus."

The afternoon session was devoted to a round table discussion of questions submitted by members of the Section.

On Tuesday morning, Mary Virginia Stallworth read a paper, "Some Considerations in the Selection of Patients for Orthoptics." Dr. William C. Owens of the Ocular Research Division, Walter Reed Hospital, gave a paper, "A Consideration of Vertical Anomalies in Orthoptics." In the afternoon a paper, "Divergent Strabismus," was given by Dr. L. D. Lide, Jr., of Florence, S. C.

Following the last paper the meeting closed with a business meeting. Betty Christ was elected chairman for next year, and Hattie Mae Benson, secretary-treasurer, with the meeting to be held in Tampa, Florida.

Seven members of the Section and one guest attended the meeting.

Western Section: University of Oregon
Medical School
Portland, Oregon
April 30, May 1, 1954
Ruth Wahlgren,
Chairman

The Western meeting was attended by eleven orthoptic technicians. Although this may not seem like a large number, we felt it compared favorably with the number present at previous Western meetings. We have a total of thirty-one AAOT members in the Western Section, but geographically our section covers a large expanse of country, from southern California to British Columbia.

Dr. Kenneth C. Swan, head of the Department of Ophthalmology at the Univer-

sity of Oregon Medical School, opened the meeting with a discussion of "The Blindspot Mechanism in Strabismus," which proved of great interest to the technicians. He touched not only on the "blindspot syndrome" but also the part the blindspot plays in other types of strabismus, and the role of orthoptics for patients who utilize the blindspot.

Dr. John E. Harris, staff member in the Ophthalmology Department, talked with us on "Nature of the Visual Stimulus." His discussion of the nature of light and how we see was stimulating, and, as Dr. Harris put it, his topic "provided the cultural aspect of orthoptics."

Dr. Robert V. Hill, ophthalmologist from Longview, Washington, spoke on "Accommodation-Convergence Relationship."

Five orthoptic technicians presented some very fine papers. Julia Lancaster's paper, "Some Techniques for Analysis and Treatment of Suppression," was read to the group, as Miss Lancaster could not attend the meeting. She gave us many new ideas and practical helps. LeRoy White talked on "The Role of Accommodation in Orthoptic Training"; and "Techniques in Treatment of Adult Heterophoria" was presented by Jack Rosenfeld. Catherine Lunn told us about "The Development of Orthoptics in British Columbia," and Faith Martin, a British orthoptist from Victoria, B. C., talked on "The Orthoptic Investigation of Paralytic Squint."

An excellent motion picture on "Surgery in Strabismus" was enthusiastically received, especially by those who have not seen muscle surgery. This film was made in the Ophthalmology Department at the University of Oregon Medical School. All in all, we had a lively group and some good discussions which gave us all some new ideas.

Catherine Lunn was selected chairman of the next Western Section meeting, which will be held in May 1955 in the Orthoptic Clinic, Vancouver General Hospital, Vancouver, B. C.

Midwestern Section: Mayo Clinic—
Section of
Ophthalmology
Rochester, Minn.
May 3 and 4, 1954
Mary Cronin,
Chairman

Due to inclement weather, a blizzard in May, Doctor Rucker could not get back from a trip in time to give the welcoming address. Dr. T. G. Martens opened the meeting with a few words of welcome and then presented a paper on "The Management of Divergent Strabismus." Doctor Martens divided divergent strabismus into two groups, constant and intermittent, giving orthoptic and surgical treatment of each type

A motion picture on "Surgery of the Oblique Muscles," which had been prepared by Walter Fink, M.D., of Minneapolis, Minn., was most interesting and instructive. To those who have had little opportunity to watch surgery, it was especially interesting.

Dr. V. L. Lindberg gave a paper on "The Relationship of Ophthalmologist and Orthoptic Technician." Doctor Lindberg pointed out that the technician should be careful of the information she gives the parents. There should be an organized outline of treatment of each patient between ophthalmologist and technician. A technician should undersell orthoptics to a doctor who is not familiar with orthoptics and its possibilities rather than oversell.

Kenneth N. Ogle, Ph. D., gave some "Comments on Fixation Disparity." Doctor Ogle remarked that the targets should consist of things familiar and dissimilar, the grosser the target the greater the disparity. Motor imbalance, strength of fusion compulsion, target and individual variations must be taken into consideration. While on a tour of the Mayo Clinic, Doctor Ogle showed us the instrument he uses.

Mary Cronin read a paper on "Adaptation to Vertical Prisms." Miss Cronin

correlated Doctor Ogle's comments on fixation disparity to the use of vertical prisms.

A tour of the Mayo Clinic closed our meeting for Monday. We were impressed by the equipment for research and treatment, and felt that much time, thought, effort and money had gone into making such a fabulous clinic.

On Tuesday morning, Dr. C. W. Rucker opened our meeting with a paper on "Etiology of Paralytic Strabismus." Doctor Rucker pointed out different causes for third, fourth and sixth nerve paralyses, such as trauma, aneurysm, vascular disease, head injuries, and neoplasm.

M. E. Burns read a paper on "Selection of Cases for Orthoptics," which pointed out that cases should be selected carefully and with discretion.

A motion picture on "Anatomy of the Orbit" was commented on by W. H. Hollinshead, Ph.D. The film clearly and precisely showed the nerves and muscles in the orbit.

Last on the program was Mrs. B. Goggin, secretary of the Midwestern group, who spoke on "Slide Making" and gave some useful information on materials to use for slides and where to obtain them. I'm sure if you would write to her, she would be glad to give you the information.

Twenty-nine technicians, all members of the Section, attended the meeting.

The next Midwestern meeting will be held May 2 and 3, 1955, in Milwaukee, Wisconsin. Dolores Engel is chairman and Merelyn Chesner, secretary.

PEDIATRICS—OPHTHALMOLOGY—ORTHOPTIC EXHIBIT

This year we had our first opportunity to present the subject of orthoptics to pediatricians at their annual Academy meeting, which took place October 4-7, 1954, at the Palmer House in Chicago.

By invitation, the Department of Ophthalmology, State University of Iowa, with the cooperation of the American Orthoptic Council and the American Association of Orthoptic Technicians prepared an exhibit entitled "The Cross-Eyed Child." A poster containing several pertinent statements about the value and limitations of orthoptics formed the center of a group of enlarged photographs showing typical cases of accommodative esotropia (with and without glasses), partially accommodative esotropia, nonaccommodative esotropia, alternating exotropia, twins with high myopia and esotropia, hypertropia with head tilt, ptosis, and epicanthus. Each photograph was supplemented by a simple legend written in the first person, as though the child were describing his case.

A mimeographed brochure, further emphasizing the importance of early investigation and treatment of strabismus in obtaining functional as well as cosmetic results, was prepared for distribution.

The exhibit was very well received, and the enthusiasm shown by pediatricians was most gratifying. Our impression was that as ophthalmologists expand their facilities for examining and beginning the passive treatment (glasses and occlusion) of the very young patient, the majority of pediatricians will be more than willing to cooperate. Pediatricians have an advantage in that their specialization gives them the experience in dealing with children which most ophthalmologists must cultivate in addition to their own specialty.

The newly established Committee on Exhibits is a step toward better understanding and cooperation between pediatricians, general practitioners and ophthalmologists through organized exhibits for appropriate meetings. The early referral of more strabismus cases will be assured, more emphasis will be placed on the prevention of many of the "bug-a-boos" of orthoptics, and we will be better able to evaluate which cases can use our time and effort to best advantage when the age of readiness for active orthoptics arrives.

ELSIE H. LAUGHLIN

THE AMERICAN ORTHOPTIC COUNCIL — 1955

The American Orthoptic Council is composed of three representatives each from the American Ophthalmological Society, the Section of Ophthalmology of the American Medical Association, the American Academy of Ophthalmology and Otolaryngology, and the American College of Surgeons. Four associate members are elected from the American Association of Orthoptic Technicians.

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CLASSIFICATION

1. Accommodation
2. Amblyopia
3. Correspondence
4. Depth Perception
5. Diagnosis
6. Miotics
7. Miscellaneous
8. Nystagmus
9. Refraction
10. Stereopsis
11. Surgery
12. Treatment
13. Visual Acuity

1-1

Egan, John A.: *A new test for accommodation*, Am. J. Ophth., 37:429-430 (March) 1954

In testing accommodation Egan found that it is often difficult for a patient to tell when the test letter(s) first become blurred. He recommends testing each eye separately while the patient is wearing a full correction, and adding a correcting cross cylinder of specified strength. As the Jacques blur-point card is brought closer, the patient notes when the horizontal lines appear to be darker than the vertical. At this point the Prince rule is used, as in other tests for accommodation. For the presbyopic patient, a +3.00 add is used for testing and then subtracted from the results. The author feels that the patient can respond with more accuracy when he has two lines to compare.

2-1

Pugh, Mary: *Foveal vision in amblyopia*, Brit. J. Ophth., 38:321-331 (June) 1954

The purpose behind the author's investigation was "to obtain further evidence which might assist in the localization of the site or sites of inhibition which lead to the reduced visual acuity found to be present in amblyopia." A hundred cases were selected on the basis that the patients were good observers. The ages ranged from 10 to 55 years and their visual acuity, from hand movements to 6/12.

This series presented a slight contradiction to the previous evidence which favored the cortex as the inhibitional site. The author's investigation demonstrated that only about 50 per cent of the cases showed the cortex as the main site of inhibition and that "it was when the eyes were approximately straight that the cortex was more likely to be that main site of inhibition." The percentage of cortical inhibition was higher in those with "indefinite retinal correspondence" than in those with definite abnormal retinal correspondence. In many of the patients with definite abnormal retinal correspondence any cortical inhibition "brought about by the stimulus of the good eye was so slight that it could not be readily demonstrated." Anomalies of foveal vision "were manifest in the alteration of acuity according to the direction of fixation."

The author found the connection between the angle of deviation, retinal correspondence and cortical suppression suggestive of some local change in the photoreceptors of the fovea. Consequently, this seemed to be an important site of defective foveal vision. The writer found that "one type of inhibition did not exclude the other, and that both types appeared to be inter-related."

"The correlation between the amount of deviation and the anomalies of foveal response is difficult to explain, but . . . the possibility of local changes in the fovea due to continued and constant deviation of the visual axis appears to be worth further investigation."

A detailed description of the investigation, methods and procedures, is given along with targets, tables and diagrams of pertinent data.

3-1

Francois, J. and James, M.: *Retinal correspondence,* Ann. d'ocul., 187:793-804 (Sept.) 1954

In a series of 1300 cases of strabismus, the author found (a) true abnormal correspondence in only 19 cases (1.46%), (b) loss of normal correspondence in 9 cases (0.7%), (c) eccentric fixation in 19 cases (1.46%), (d) loss of central fixation in 69 cases (5.3%) and (e) amblyopia in 738 cases (56.8%).

The authors stress that anomalous correspondence is a binocular phenomenon, while loss of central fixation and eccentric fixation are monocular. They should not be confused.

Loss of central fixation indicates an advanced degree of amblyopia and occurs in strabismus cases with an early onset (not especially congenital cases). It is characterized by searching nystagmus due to the eye attempting to fixate. When the central scotoma is due to strabismus, the occlusion prognosis is excellent up to the age of 8 or 10 years. Improvement of visual acuity is easily reached after four months and can be obtained after one month if orthoptic training is done.

Eccentric fixation indicates an advanced form of amblyopia ex anopsia. It is characterized by the following (a) the fovea function is so diminished that a paramacular point gives better vision, and it is the point which is used for fixation; (b) this same point of the paramacular area is used even after the eyes have been straightened by surgery; (c) when the fixing eye is covered, the deviated eye does not shift to recover central fixation; (d) the amblyopia is not curable (the authors, however, cite a few exceptional cases); (e) it is observed only in monocular strabismus (convergent, rarely divergent); (f) onset of strabismus is usually at birth or very soon after birth; and (g) surgical results are usually poor because the eyes tend to converge postoperatively. The authors believe surgery should be postponed until the accommodation is less active and that "there is not, there never has been, and there never will be binocular vision, even rudimental."

The authors also distinguish between loss of normal correspondence and true anomalous correspondence.

In loss of normal correspondence there is (1) no binocular vision, not even simultaneous vision, (2) no subjective angle of strabismus, only an attempt to coincide the two images at a smaller angle than the angle of strabismus, (3) deep amblyopia, frequently cured (recovery of binocular vision) by orthoptics, (4) a high degree of refractive error (+3D), (5) an accommodative element which is important at the origin, and (6) early onset.

In true anomalous retinal correspondence there is (1) peripheral binocular vision (simultaneous vision and imperfect fusion), (2) a subjective angle different from the objective angle, (3) slight amblyopia, which can be easily cured, (4) eyes ± emmetropic, (5) no accommodative element, (6) onset about 2 or 3 years; and (7) this type of anomalous correspondence is not curable, even after surgery, the angle of anomaly staying the same even when the optic axes are parallel.

3-2

Hansen, A. K.: *"After-image transfer test" in anomalous retinal correspondence,* A. M.A. Arch. Ophth. 52:369-374 (Sept.) 1954

The method of testing retinal correspondence by means of the "after-image transfer test" as reported by Jaffe is described.

A group of patients, eighteen with anomalous retinal correspondence, twelve with exophoria, and twelve who were orthophoric, were tested by this method at the University Hospitals in Iowa City. A table showing the results of the test is given. The author concludes from these results that patients with anomalous correspondence do not respond to the "after-image transfer test" in a different manner than do those with normal correspondence.

Those patients who are unaware of an after-image in the unexposed eye probably have strong suppression.

3-3

Lavinge, M.: *Value of abnormal retinal correspondence in binocular vision,* Brit. J. Ophth., 38:332-344 (June) 1954

The author states that "abnormal retinal correspondence is a physiological part of normal binocular vision in many persons and is a natural accompaniment of the binocular adjustment when the visual axes are not parallel in all positions. . . . It is suggested that, since the phenomenon occurs only in free vision, present methods of investigation fall short in their duplication of normal visual conditions, and that the resulting responses may be an inadequate indication of the patient's true degree of adaptation." The writer goes on to say "Abnormal retinal correspondence does not create

an unfavorable surgical prognosis, but it cannot be eradicated by orthoptic treatment or replaced by normal correspondence. It is a condition to be encouraged, and attempts to eliminate it are based on a faulty appreciation of its value and purpose."

In a discussion of the diagnostic tests, the author favors the double-image test as being the most accurate, even though the red filter may dissociate the test from normal visual conditions. The synoptophore is found to be inadequate in the diagnosis of small degrees of esotropia and diagnostically inadequate in patients with large areas of intense suppression.

Harmonious-type abnormal retinal correspondence is considered an ideal adaptation. Duplication of normal conditions of seeing without dissociation of the two eyes is not viewed as possible. However, utilization of polaroid lenses in a projection test is described and diagrammed. Tables are included showing comparative findings in various types of binocular adaptation.

A suggested routine treatment of strabismus associated with abnormal retinal correspondence is (1) to overcome amblyopia by occlusion; then (2) to correct the deviation by surgery where this is cosmetically indicated; and finally (3) to attempt to consolidate the result, using anomalous retinal correspondence, when it is sufficiently grounded, as a basis for orthoptic treatment.

4-1

Miles, Paul W.: *Analysis of depth factors in anisopia and anisodominance,* Am. J. Ophth., 37:98-106 (Jan.) 1954

The author discusses two newly discovered types of defective depth perception.

The first type, "anisopia," is described as a depth error consisting of "apparent individual rotation of flat contrasting objects."

In the second type, "anisodominance," other clues to depth perception being equal, the right-eyed individuals see the right one of two or more equidistant objects nearer, while left-eyed persons see the left one nearer.

"The central binocular visual field is bounded on the right by a crescent visible only to the right eye, and on the left by a crescent visible only to the left. The comparative brightness of objects in these crescents would depend on ocular dominance."

"Pugh found that a recessive eye of normal visual acuity might require as much as 100 times more light for subjective equality with the dominant eye in a haploscope (amblyoscope). In right ocular dominance, an object in the right monocular crescent would appear brighter than a similar object in the left. Under certain conditions of background and contrast, the brighter object would also appear nearer."

Dr. Miles points out that anisopia and anisodominance are produced by irradiation differences in corresponding retinal images.

In conclusion, Dr. Miles says, "Anisopia is an anomaly of depth perception in which the retinal image of one eye is different in intensity or focus, causing an apparent rotation on each central vertical axis of frontal plane within certain limits of size, separation and contrast." He also points out that anisopia is limited in distance by stereopsis.

"Anisodominance is an anomaly of binocular depth perception which is related to ocular dominance or to unilateral defects in retinal image intensity or focus, but instead of apparent rotation of individual objects, it produces simple differences in perceived object distance." Anisodominance does not require stereopsis.

5-1

Luhr, John P., and Schlossman, Abraham: *Intermittent and accommodative esotropia,* Am. J. Ophth., 38:191-194 (August) 1954

This is an analytical report of 74 cases. Intermittent esotropia is classified as that deviation which is intermittent for both distance and near or esotropia for near and esophoria for distance. The accommodative esotropia is that deviation which is a uniocular squint converted by lenses into intermittent esotropia, esophoria or orthophoria. The two types are so closely related, with almost interchangeable features, that the authors have grouped them together.

The most significant factors in determining the prognosis for nonsurgical treatment are listed as follows: age at onset, visual acuity, refractive error, near-point of convergence, fusional status and progress of case.

The age of patients at onset of symptoms was between 2 and 6 years in 77 percent of the cases reviewed; before 2 years in 14 percent of the cases; and after 6 years in only 9 percent of the cases. Whereas 15 percent were so-called alternators, the rest were uniocular cases. Few of them showed any marked degree of amblyopia. The visual acuity was equal or nearly so in both eyes in 80 percent of the patients.

The visual acuity of three patients failed to improve beyond 20/50 as the angle of squint improved. Except for one patient, all had hyperopia greater than one diopter and 23 percent had astigmatism of one diopter or more. No demonstrable relationship existed between the amount of hyperopia and degree of deviation.

Forty-two percent of the patients had a remote near point of convergence, but they did as well as those with unlimited near points. Retinal correspondence was normal and 47.3 percent showed all grades of fusion; 24 percent not examined with a major amblyoscope fused the Worth four-dot test; and 9.4 percent had intermittent fusion, while only 9 percent failed to show any evidence of fusion.

In all but eight patients the deviation was greater for near than for distance, and the majority measured less than 35 prism diopters of esotropia for near. As a group, the patients responded satisfactorily to their full corrections. "In some cases the strabismus was converted to esophoria or orthophoria within two to three months, while in other cases it took over a year before the strabismus was fully corrected. . . . Improvement occurred in many patients without orthoptics or even patching the fixing eye. Only three cases were felt to warrant orthoptic training, indicating that the great majority of these cases need only removal of the accommodative element in order to improve. Corrective surgery was not performed on any of these patients."

The authors believe that bifocals are useful for patients whose glasses fully correct the distance deviation but leave a small residual angle for near. In closing, they conclude that there is a good chance for correction without surgery if the onset occurs between the ages of 4 and 6 years (the fusion faculty is functioning, the vision is equal) and if hyperopia under cycloplegia is from 3 to 5 diopters.

5-2

Schlossman, A.: *Diagnosis of muscle paresis,* Eye, Ear, Nose & Throat Monthly, 33:429 (July) 1954

The author points out that when a single muscle is paretic it is usually a lateral rectus or superior oblique, since these two muscles have an independent nerve supply. Diabetes, multiple sclerosis, intracranial hemorrhage, and poliomyelitis are often causes of extraocular muscle paresis.

Examination consists of (1) versions done in the six cardinal directions, (2) ductions done with each eye fixing (the examiner watching not only the fixing eye but also the eye behind the cover in order that he may pick up a primary and secondary deviation), and (3) diplopia tests done in the six cardinal directions to determine the field in which the greatest separation occurs.

When more than one muscle is involved or when the paresis is long established and the deviation has become concomitant, diagnosis is difficult and may have to be determined by means of more exacting tests.

5-3

Urist, Martin: *Exotropia with bilateral elevation in adduction (Part I),* Am J. Ophth., 38:58-65 (July) 1954

This paper deals with diagnosis. It is pointed out that the vertical deviations are secondary to the disassociation of the eyes caused by exotropia. In 102 case studies it was found that 40 percent had a history of onset at birth and 80 percent a history of onset before five years of age. Hypermetropia was the predominant refractive error. In the studies made, the near point of convergence varied from day to day and from one examiner to another. In no case did the corneal reflex test show an exotropia greater for near than for distance, whereas in the prism cover test the opposite was frequently true. This is explained by the fact that careful fixation is required in the prism cover test, and because of this, convergence and fusion are stimulated and at least part of the deviation is controlled, whereas in the corneal reflex test the child merely fixes on a light.

Dr. Urist believes that the most consistent and best diagnostic findings in these cases result from the comparison of the straight-up and straight-down position measurements. Vertical deviations were found in 81 percent of the 102 cases studied. His tests proved that the deviation was over 90 percent greater when the patient looked up than when he looked down.

"In 73 percent of the cases bilateral elevation in adduction was observed." Two case reports are presented and are accompanied by pictures. The author states, "It has not been my experience that all cases with an exotropia greater than 18 diopters for distance require surgery. . . . As long as good vision and fusion are maintained for near, there is no urgent need for surgery."

In the 88 cases in which the vision was recorded, 82 had equal vision; four had 20/70 visual acuity which improved to normal with occlusion; one had 20/200 and one had 5/200 with eccentric fixation in the amblyopic eye. Both of the latter cases improved to 20/30 within six months by occlusion of the fixing eye.

In summary, Dr. Urist classes most cases of "intermittent exotropia" as "exotropia with bilateral elevation in adduction." He classifies the important findings as follows: "(1) Bilateral elevation in adduction, (2) a greater exotropia for distance than for near, (3) a greater exotropia in sursumversion as compared with deorsumversion, and (4) characteristic vertical deviations, which are a left hypertropia that is greater in dextro-elevation and right hypertropia greater in levo-elevation."

6-1

Hubert, A.: *Les myotiques dans le traitement du strabisme concomitant*, Ann. d'ocul. 187:576-577 (June) 1954

It is known that miotics provoke an accommodative spasm, in addition to miosis and decrease of the intraocular pressure. It is this spasm which is utilized in the treatment of convergent concomitant strabismus (relaxation of the accommodation, a relaxation parallel to the convergence, and a decrease of the angle of strabismus).

To obtain a marked effect, strong miotics must be used (eserine, DFP, mintacol). The author recommends daily use of a 0.5 percent solution of mintacol (Bayer) in both eyes (preferably in the morning) for several months. Favorable indication for the use of miotics is accommodative esotropia (cases of high or medium hyperopia, and late onset, between 2 and 3 years).

The intermittent types not yet fixed answer best to the therapy. A unilateral amblyopia does not prevent success. Often, the miotic (a) makes it possible to leave the glasses off, (b) reduces the angle of deviation a larger amount than just the wearing of glasses does.

Divergent concomitant strabismus is not influenced by this therapy.

6-2

Schlossman, A.: *Miotics in the treatment of strabismus*, Eye, Ear, Nose & Throat Monthly, 33:538 (Sept.) 1954

The author explains that, by stimulating accommodation and thus decreasing accommodative effort and the convergence innervation which accompanies it, miotics may improve or even eliminate a convergent strabismus. DFP (in dilutions of 0.01, 0.02 or 0.03 percent) has a more prolonged action than pilocarpine or eserine, but is more apt to produce intraepithelial cysts along the pupillary edge of the iris.

Dr. Schlossman suggests the use of miotics in cases of accommodative convergent strabismus only, and recommends it sparingly, since accommodative squints are responsive to treatment with full correction of their refractive errors, bifocals and/or orthoptic training.

7-1

Gordon, Orville E.: *A study of primary and auxiliary medial ocular rotation*, Tr. Am. Acad. Ophth., 58:553-560 (July-August) 1954

The portion of the eye muscle which lies in contact with the eyeball, at the point of insertion, is known as the "arc of contact." As a muscle contracts, rotating the eye about the center of rotation, the muscle unwraps and the arc of contact becomes exhausted. No record of measurements or of analysis to account for the known ocular movements can be found.

Twelve human eyes were measured after they had been preserved and inflated to normal contour. Using 72 mm. as the circumference of the eyeball, it was estimated that each millimeter of the circumference was equal to 5 degrees. By multiplying the length of the arc of contact of each muscle by this number, the degrees of rotation permitted were determined.

It was found that the arc of contact was more than adequate for lateral rotation. For medial rotation there was a difference of 15 degrees which had to be accounted for. A search was made to see if others had found the same problem. Dr. Gordon did not find any satisfactory reports in the literature.

Torsion, elevation (or depression) and medial rotation are the components of the force of each muscle. The medial rectus muscle gains some help from the inferior and superior recti for rotation, the torsion and elevation-depression balance out. Having formulated this hypothesis, research was carried out to test it.

At two local hospitals, work was done on eyes which were to be enucleated and which satisfied certain criteria. In the course of a year, six suitable cases (which are described briefly) were found. The conclusions were that the arc of contact of the medial rectus muscle allows a certain degree of internal rotation, but beyond that, internal rotation is provided by another mechanism. It was indicated that the mechanism was provided by the combined action of the superior and inferior recti.

If a definite relationship between medial rotation and vertical acting muscles has been established, it is hoped that some of the unanticipated results in muscle surgery will have an explanation. However, Dr. Gordon feels that there is need for further investigation.

7-2

Schlossman, A.: *Headache as an ophthalmologic symptom,* Eye, Ear, Nose & Throat Monthly, 33:241 (April) 1954

The author stresses four main ocular disorders which may cause headache:

1. Lesions in the intracranial pathways. Fundoscopic and visual field examinations are of primary importance in diagnosing these cases.

2. Glaucoma. "Headache is not a characteristic symptom of chronic simple glaucoma, but when optic atrophy without cupping is present, glaucoma should be suspected."

3. Refractive problems. These may include incorrect handling of astigmatic error or spasm of accommodation.

4. Heterophoria. If hyperphoria is present, the author suggests the use of prisms in glasses. The amount of this prism is determined by checking deorsumvergence and sursumvergence, adding the two algebraically and dividing by two. Exophoria is more often the cause of headache than is esophoria. Poor convergence amplitude is usually the precipitating factor. Convergence and divergence should maintain the ratio of approximately 3:1. If the ratio is considerably less than 3:1, simple convergence exercises should be initiated.

7-3

Wheeler, Maynard C.: *Strabismus, annual review,* A.M.A. Arch. Ophth., 52:134-159 (July) 1954

The author discusses world literature on strabismus for 1953.

"The outstanding event in the field of strabismus during 1953 was the publication, by the American Academy of Ophthalmology and Otolaryngology, of the symposium on strabismus, held at the annual meeting in October, 1952."

"Another important event was the appearance of the fifth edition of 'Gifford's Textbook of Ophthalmology,' by Adler."

Asher's theory of binocular vision is presented.

Winkelman's work on peripheral fusion is discussed briefly.

According to the literature presented by those who have studied the phenomenon of anomalous correspondence, opinions differ on this subject. Rönne and Rindziunski divide abnormalities in sensorial relationship into five stages, the prognosis becoming worse with each stage.

Characteristics of 80 selected cases of slight esotropia or intermittent esophoria by Gittoes-Davies are given. It was concluded that these patients had a fixation disparity rather than a true manifest deviation.

Another significant contribution to appear in 1953 was Bangerter's 96-page monograph on the treatment of amblyopia. This is discussed by Wheeler, who concludes that this program of treatment may prove to be very important although he is doubtful that it could be rapidly adopted in this country.

One of the most significant papers to appear in 1953 was by Knapp on intermittent exotropia. This paper explains the development of this condition and a logical approach to the treatment.

Among several articles on surgical treatment of strabismus published in 1953, is one from France on the surgical treatment of concomitant strabismus by Parfonry and Polliot. In reviewing this article the author states, "The authors are arguing against all our modern concepts of the nature and treatment of strabismus."

There are a number of interesting articles on orthoptics, presented in 1953, which include three from South America.

8-1

Anderson, J. Ringland: *Latent nystagmus and alternating hyperphoria,* Brit. J. Ophth., 38:217-231 (April) 1954

The author states that of 34,000 patients, 138 showed congenital nystagmus; of these 138, at least 20 had "latent nystagmus." It was noted that almost all the patients with this condition were young. The oldest of the 20 patients was 32, and the youngest 19 months.

Strabismus was found in all but one case. In 11 it was convergent, and in 5 divergent. Overaction of the inferior oblique muscles was observed in 11 of the series. One patient appeared to have full versions, and his was the only more or less typical case with no alternating hyperphoria.

The author found that there was no consanguinity and no obvious sign of inheritance. The incidence of difficulties at birth was high.

Two typical means of revealing latent nystagmus were suggested: (1) covering one eye, and (2) conjugate deviation. The following methods were listed as being sometimes adequate: (3) shades of varying intensity before one eye, (4) high convex lens before one eye, (5) high convex lenses before both eyes, (6) prisms before one or both eyes, (7) convergence may lessen the nystagmus but in some

cases it has increased it, (8) covering part of the field, especially the macular region, bar reading or on looking toward the nose, (9) a bright light shining into one eye. By methods 5 and 6, contradictory results were obtained.

The writer noted the number of cases with rotatory nystagmus. "All except one of them changed to horizontal movements on occlusion. As the majority of the patients in this series had defective balance of the inferior oblique muscles it is likely that such imbalance can explain the frequency of these rotatory movements around the antero-posterior axis."

A few case histories and tables are included along with a discussion of the term "alternating hyperphoria."

A few excerpts from the author's tentative conclusions are as follows: (1) Latent nystagmus may be regarded as an entity. It shows variations, but is characterized by its appearance on occlusion of either eye. (2) With one exception, every case of latent nystagmus in this series showed alternating hyperphoria. Both conditions can be increased by nervous tension and fatigue. (3) The rotatory form of nystagmus is probably due to oblique muscle imbalance. (4) It is suggested that latent nystagmus and alternating hyperphoria may be due to arrested development of the oculomotor mechanisms that underlie binocular fixation. (5) Latent nystagmus appeared to grow less with age in some patients, but no diminution of alternating hyperphoria was observed.

9-1

Sloane, Albert E.; Dunphy, Edwin B.; Emmons, William V.; and Gallagher, Roswell J.: *A comparison of refraction results on the same individuals*, Am. J. Ophth., 37:696-699 (May) 1954

A chart is presented showing the naked vision, correction and corrected vision on 21 subjects tested by three different qualified examiners on the same day and under the same conditions in order to compare results obtained and to bear out consistency of clinical findings. Subjects ranged in age from 14 to 18 years and all were above average intelligence. In only one instance were the findings of the three examiners identical. The variations, however, were not great and were considered to be well within each subject's tolerance.

These data would seem to indicate that differences in test findings are inevitable even under well controlled conditions. The authors feel that the differences shown are within "expected variations." That one cannot reasonably be dogmatic about a refractive error is shown.

A second table lists the measurements of heterophoria for distance and near on just 10 of the male subjects. No attempt is made to evaluate the reasons for the many variations found.

10-1

Charnwood, L.: *Stereopsis in presence of diplopia*, Brit. J. Physiol. Optics 11:8-9 (Jan.) 1954

Lord Charnwood's impression on this subject is presented. When two or more point targets are aligned with the binoculus, only one can be seen singly, the others are seen in diplopia. The targets seen in diplopia always appear to be beyond the point of fixation, even when they are in fact nearer, and no incentive to fusion is experienced.

In order to reconcile this observation with the fact that diplopia does not normally prevent stereopsis, it is suggested that fusion may be mediated by separate cells in the cortex, and possibly by separate retinal receptors, and that this system is missing or almost missing in the neighborhood of the macula. The writer also suggests that it is the sign of the fusional impulse from this system which gives the sense of depth usually experienced from the targets seen in diplopia.

His method of experiment is described.

10-2

Morgan, Alan A.: *Stereoscopic vision in relation to photo-interpretation*, Brit. J. Ophth., 38:29-34 (Jan.) 1954

The author states that during the war, intelligence reports depended partly on correct interpretation of operational photographs and, in turn, on the interpreter's specialized knowledge of the subject and his stereoscopic sense. Accordingly, "an attempt has been made to determine the value of stereoscopic training in photo-interpretation and to ascertain the effect of suppression changes and refractive errors on stereoscopic vision."

In the subjects studied, one group was stereoptically trained and the others acted as controls. Grading and training were done on Holmes' stereoscopes with the rotating stereograms of Livingston (1939).

Although the number of personnel was very small, the results suggested the following: (1) All trained personnel showed a definite improvement on Chart 5 after their course of training. (2) The majority of untrained personnel showed little or no improvement on Chart 5. (3) In

the interpretation of operational photographs there seemed very little to choose between trained and untrained personnel, but, on the whole, the trained did a little better.

"It has been noticed that it is not uncommon for personnel to complain of ocular symptoms such as tiredness of the eyes and headaches after beginning to use the stereoscope in photo-interpretation. This is merely due to ocular fatigue . . . ." The symptoms usually wear off in a week or two. According to the author, "stereoscopic work per se has no evil effects on the eyes, and there is no reason at all why any refractive errors already present should be increased as a result of the stereoscopic work. However it should be done under proper conditions, especially with adequate lighting and good arrangements of chairs and desks."

The author found that suppression changes were far more important than visual acuity as regards standards for recruits undertaking photo-interpretation.

The following are some of the standards recommended:

1. Visual Acuity: 6/60 or better in each eye, correctable to 6/6.

2. Convergence: 4" or better.

3. No cases of complete suppression should be accepted.

"It is recommended that all personnel, . . . should have a complete course of stereoscopic training with daily exercises."

11-1

Alvaro, M. E.: *Simultaneous surgical correction of vertical and horizontal deviations*, Eye, Ear, Nose & Throat Monthly, 33:420 (July) 1954

The author reviews literature and the case histories reported by Foster and Pemberton relating to raising or lowering the insertion of either horizontal rectus muscle to produce a vertical effect. He reports on 11 of his own cases in which he corrected both horizontal and vertical deviations by operating on the medial and lateral recti only. Raising the insertion of a rectus muscle produces an elevation of the anterior pole of the globe; lowering the insertion produces a depression of the anterior pole. He found that for each millimeter the rectus muscle was transplanted vertically, he achieved approximately 1 degree of correction of the vertical strabismus.

11-2

Fink, Walter H.: *Present concepts of superior oblique surgery*, Am. J. Ophth., 37:548-557 (April) 1954

Dr. Fink points out that prior to 1942 there is very little reference in the literature to superior oblique surgery because it was believed that, due to its deep and unusual insertion, operation on this muscle was not practical.

The new tendency on the part of some surgeons is to confine the operative procedure to the field involved because of a better understanding of the anatomy and the defects of this muscle, new methods of diagnosing and managing these cases, and more effective surgical procedures.

Dr. Fink makes the following points: (1) A superior oblique defect in heterotropia is an important obstacle to binocular coordination and when associated with horizontal deviations is often the true underlying imbalance, the latter being secondary. (2) There is need for more definite criteria for differentiating vertical defects to eliminate great variances in statistics regarding these offenders. (3) Observation of the head tilt of the patient, and use of Bielschowsky's test will implicate the superior oblique as an offender in a larger percentage of cases than was thought heretofore. (4) Knowledge of the fixating eye and the duration of involvement are important for diagnosis, as is the determination of the amount of deviation in the down and in position. Other valuable tests include the prism and cover test, versions, and the Lancaster red-green test.

Our present concept of superior oblique surgery stresses early surgery to prevent torticollis, changes in the affected muscle as well as in its synergists and antagonists, suppression, amblyopia and undesirable cosmetic, psychologic and social effects. Wearing of the proper refractive correction is important, and prisms are useful if there is a fairly large field of comitancy. Fusion exercises are of little value in increasing the patient's ability to overcome his symptoms and may cause secondary contractions to become more pronounced.

Because of the many complications resulting from vertical recti surgery, Dr. Fink reserves operation on these muscles for a second procedure whenever possible. He selects the offending oblique muscle as carefully as possible and operates to strengthen this muscle in most instances. He cautions against ill-advised surgical operations on the superior oblique, especially on adults, which may result in diplopia. He stresses careful selection of the surgical procedure to be used. Personally, the author pre-

fers the use of the tuck operation in underaction of the superior oblique and finds it easiest when using the instrument devised by him for tucking.

11-3

Urist, Martin: *Exotropia with bilateral elevation in adduction (Part 2)*, Am. J. Ophth., 38:178-190 (August) 1954

This paper presents and discusses the results of surgical intervention in Dr. Urist's series of 54 cases. All cases have been followed from one to seven years after the surgery, and the author states that findings confirm the results of Scobee "which show that the bilateral recession of the lateral rectus muscles gave a functional cure in the majority of cases." Dr. Urist states that, "In our series the functional cures were consistently obtained with the bilateral recession of the lateral rectus muscles in those cases that had an exotropia for distance and upward gaze and straight eyes for near and looking down. The ability to hold the eyes straight for near and looking down maintained vision and developed fusion amplitude . . . ." The latter, he believed, insured a functional cure postoperatively.

The author pointed out that the bilateral simple tenotomy gave an undercorrection in the majority of cases and that the results were poor with resection of the medial rectus alone. Recession of the lateral rectus muscle and resection of a medial rectus when unilateral produced an undercorrection in most cases. The cases were divided into two categories for surgical treatment: "(1) those with no underaction of the medial recti, manifested by straight eyes for near and downward gaze; and (2) those with underaction of the medial recti manifested by an exotropia for near and downward gaze which is less than that for distance and upward gaze." The procedure recommended for type 1 is a bilateral recession of the lateral rectus muscles. For type 2 the recommended surgery is a unilateral or bilateral resection of the medial rectus muscles in addition to the bilateral recession of the lateral rectus muscles. If the resection of the medial rectus is not done, the exotropia in the downward gaze may remain uncorrected.

In summarizing this paper, Dr. Urist states: "The bilateral resection of the medial rectus muscles is contraindicated as a primary procedure for the cases that have straight eyes for near and looking down . . . because it produces overaction of the medial rectus muscles without correcting the primary defect which is overaction of the lateral rectus muscles and may result in an esotropia on looking down."

Dr. Urist feels that the correction of the exotropia for all positions will cause enough improvement in the vertical deviation so that in many cases a recession of the inferior oblique will not be necessary.

12-1

Law, Frank W.: *Squint operations and binocular functions*, Tr. Am. Acad. Ophth., 58:546-552 (July-August) 1954

Mr. Law reviews his results in treating strabismus cases. He chose a rather small number of cases of concomitant strabismus (40 consecutive unselected cases from his private practice). Private patients were selected because of the close supervision by him and his orthoptist. Persistent orthoptic treatment was not used in cases which did not appear to lead to fruitful results.

There is a detailed discussion of his surgical techniques including the favorable results as well as some of the problems encountered.

Orthoptic investigation was carried out in all cases old enough to undergo it; exercises were instituted as indicated. Surgical intervention was undertaken when it became unnecessary or undesirable for further delay. Orthoptic treatment was recommended and continued as long as it was considered necessary following the operation in appropriate cases.

Mr. Law gives a verbal analysis of this series rather than using charts and statistics. A list of factors considered in each case is given.

In view of the results obtained, Mr. Law feels that (1) binocular results are rarely achieved when the squint dates from birth; (2) it is unusual for a patient to obtain a better level of binocular vision after orthoptic treatment and surgery than he had previously; (3) well-established abnormal retinal correspondence is incurable; (4) alternation is an incidental hazard and does not affect binocular progress appreciably; and (5) there is little point in postponing surgical correction if circumstances and the psychological state are propitious. "Considered from the aspect of eliminating an angle between the visual axes, orthoptic treatment is useless. It can in most cases only exercise, exploit and facilitate the initial binocular state; it can not improve it. (The immense value of orthoptics in diagnosis, and in the treatment of phorias is not in question.)"

Mr. Law concluded that in spite of the small number of cases used in this series he arrived at the same conclusions he had already formed from his general experience. Furthermore, he felt they corresponded to the conclusions drawn from a study of larger series which had been reported.

12-2

Lindsay, J.: *New methods in orthoptics,* Brit. J. Physiol. Optics, 11:1 (Jan.) 1954

In this paper the author examines some of the basic errors in present day orthoptic training and suggests a new technique which stresses the importance of the relationship between the visual and tactile senses. Three exercises to facilitate the transfer of visual skills from orthoptic machines into daily life are described.

Requisites for new techniques: (1) There must be no interference with the normal requirements for binocular vision; in particular, the instrument must allow the patient to have the normal binocular field with its associated monocular fields. (2) There must be a means of eliciting diplopia rapidly and certainly. This can best be done by convincing the mind that there must be two objects. (3) Objects in the binocular field must be appreciated as being single. To achieve this, some aid such as prisms base in or out may be required in training when they are indicated. (4) At the earliest possible opportunity, physiological diplopia must be demonstrated, and its cause and functions explained. (5) No attempt should be made to separate the binocular functions into color, form, etc. The objects must, from the beginning of treatment, be solid and must be handled by the subject freely. (6) There must be no trick "fusion" with slides or pictures, nor should fusion be produced unless it is accompanied by physiological diplopia. (7) Emphasis should be laid on position, detailed discrimination of form being of secondary importance. (8) The solid objects used should be capable of variation and should be such that they interest the patient. (9) It should be possible to exercise certain extraocular muscles, in particular the internal and external recti. (10) Breadth of fusion (fusion at all distances) must be exercised.

The author stresses the need for research and advises against the adherence to all old, preconceived ideas. Progress can only be made by endeavoring to find fault in established methods and by endeavoring to suggest alternative methods of treatment.

12-3

Offret, G., and Lonbard, G.: *Etude statistique sur le traitement medicochirurgical du strabisme concomitant,* Bull. Soc. opht., France, 8:882 (Nov.) 1953

The authors report the results obtained in the treatment of squint within the last four years. The strabismus cases were treated at the Cochin Hospital.

Only the cases are reported in which the following examinations were done: (1) the objective measurement of the deviation; (2) retinal correspondence determined by the synoptophore and Bielchowski's test; and (3) the evaluation of the binocular status according to Worth's classification.

Ninety-seven patients were evaluated: eighty-seven had orthoptic treatment, and 10 were operated on without orthoptic treatment. Of the 87 patients who had orthoptic treatment, 35 were insufficiently treated because of irregular appointments, etc. Only 6 had postoperative orthoptic treatment. Thirty-seven had orthoptic treatment alone, and to this group were added the 9 who had preoperative and postoperative treatment, making a group of 46 patients.

In the group of 46 patients who had orthoptic treatment either alone or preoperatively, 4 cases showed complete recovery (these cases had a deviation under 25 degrees, one had anomalous correspondence). Three cases showed some degree of fusion. Fourteen cases showed improvement by one of the following factors: less deviation, normal correspondence, or attainment of second degree fusion. Fifteen cases did not present any improvement.

The authors compare the operative results obtained when patients had had preoperative orthoptic training and when patients had had no training at all. All of the patients were operated on in the same period and by the same surgeons. Postoperative results in the 10 patients without orthoptic training revealed only 1 case with a perfect result (cosmetic and functional). This one case indicates that while it is possible to recover binocular vision after surgery, such a result is rare. The patients who had had preoperative orthoptic training showed a higher percentage of functional result.

12-4

Polliot, M. L.: *Le traitement chirurgical du strabisme concomitant,* Bull. Soc. opht. France, 8: 872 (Nov.) 1953

Dr. Polliot presents the views on surgical treatment of concomitant strabismus of the late Dr. Parfonry.

The author says that Dr. Parfonry did not believe in early surgical intervention because of the following factors: (1) There is a tendency for the angle of squint to decrease as the patient become older. (2) For a good surgical result the utmost cooperation of the patient is needed. (3) Fatal accidents might occur under general anesthesia. (4) Due to the operative technique adopted by Parfonry it is necessary to obtain the patient's cooperation during the operation. The author also states that (1) Dr.

Parfonry believed that amblyopia in strabismus exists but that it is congenital, (2) he did not believe in amblyopia ex anopsia or in the utility of occlusion; and (3) he believed that the possibility of anomalous correspondence is not enough to justify early surgery. Dr. Polliot reports on Dr Parfonry's method of examination and his surgical procedure.

This report is followed by a discussion by various ophthalmologists on Dr. Parfonry's views.

12-5

Schlossman, A.: *The use of bifocals in the management of esotropia,* Eye, Ear, Nose & Throat Monthly, 33:368 (June) 1954

Bifocals, as a means of treatment, are "ideal for use by those patients whose esotropia for distance is fully corrected by glasses but who have a residual esotropia for near." If, after several months of wearing his full correction, the patient has a phoria for distance and a residual esotropia for near, the author prescribes bifocals. He uses the smallest amount of add which will neutralize the esotropia. The bifocal segment must take up the lower half of the glass, in the case of children, to prevent reading through the top segment. Dr. Schlossman suggests bifocals also for (1) hyperopes who will not tolerate full correction for distance, but whose distant esotropia is corrected by weaker glasses which do not correct the esotropia for near; (2) patients with esotropia whose deviation for distance has been corrected by surgery, but who have a residual esotropia for near; and (3) patients with esotropia with a small degree of myopia whose eyes remain straight for distance with their myopic correction, but with the increased accommodation, at near lapse into an esotropia.

13-1

Fink, Walter H.: *Method of estimating visual acuity in a young child,* Tr. Am. Acad. Ophth., 58:750 (Sept.-Oct.) 1954

Two new charts for testing visual acuity in children under five years are illustrated in this presentation. The first makes use of the stick drawing of a child with his arms in various positions; the other is a picture of a hand which may be rotated. The patient is asked to make his arms or hand look like the picture. The measurement thus recorded is only an approximation but affords a comparison of the visual acuity of both eyes.

13-2

Gordon, D. A.; Zeidner, J.; Zagorski, H. J.; and Uhlaner, J. E.: *A psychometric evaluation of the ortho-rater and wall chart tests,* Am. J. Ophth., 37:699-705 (May) 1954.

The authors present a psychometric comparison of visual acuity scores obtained on the ortho-rater plates with those obtained on similar wall chart tests. The reliabilities of the two methods of presentation are compared. Analysis indicated that both methods tested the same visual abilities. One hundred seventeen soldiers were tested binocularly with a set order of tests and then retested two weeks later.

The following conclusions were drawn: (1) the methods of presentation, except for slight discrepancies introduced by photographic reduction, were of equal difficulty; (2) the ortho-rater tests were significantly more reliable than the wall chart tests; (3) the evidence did not show that "apparatus accommodation" affected the visual acuity scores when tested by means of the ortho-rater. For measurement of far visual acuity these instruments have several advantages: the built-in light source can be made more accurate; the optically achieved viewing distance saves space; targets are changed more conveniently; and there are fewer distractions for the patient.

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